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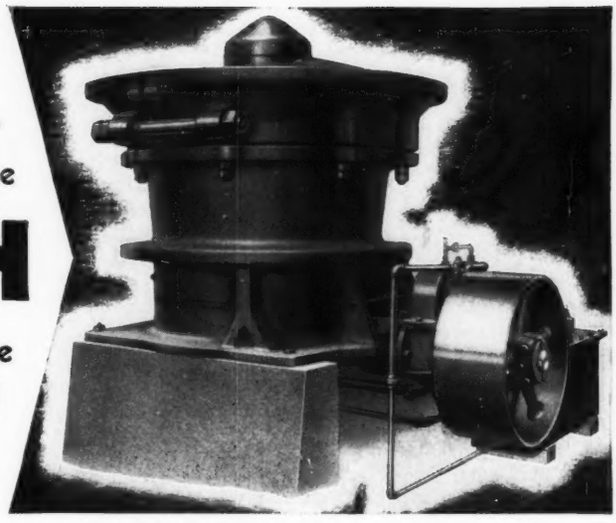

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Scientific Discovery And Economic Fact

AT FREQUENT INTERVALS the world is startled by an announcement that some scientist has discovered how to manufacture synthetic gold—a metal chosen for attention because of the romance and glamour and exchange value with which it has long been associated. But, unfortunately for promotors of schemes of dubious integrity, synthesis connotes the union of two or more elements. All metals are elements. None, therefore, can be produced synthetically.

Scientific discovery cannot put the metal industries out of business. Transmutation of one metal into another has been noted as an evolution as slow and far less controllable than the evolution of a new animate form from a primitive ancestor; but the vast amount of energy needed to transmute lead into gold, for example, suggests that a reverse process, if devised as a practicable operation in a reasonable time, offers better prospect of economic success.

Although elements are safe from the attack of the synthesist, compounds are vulnerable. Tens of thousands have been prepared artificially, but Science occasionally fails to outwit Nature in a battle for economic supremacy. Thirty years ago a German chemist produced synthetic rubber, but in the intervening period the plantation product has maintained its markets. "Synthesis" and "substitution" are words that help to make intriguing newspaper headlines; but laboratory achievement is merely the beginning of a campaign that may be brought to naught when economic facts are faced.

Is Standard Drill Steel Old Fashioned?

WHATEVER opinion may be held regarding the general application of detachable drill bits, no investigator can fail to regard with respect the performance of a bit that has found favor for several years with one large mining company in underground work. Such an example is ample proof that, under some mining conditions, it is practicable to make the drill bit as a part separate from the shank, and to organize operating work accordingly. A familiar instance is afforded by the long-continued use of the Hawkesworth bit by the Anaconda Copper company. The contention may be raised by those who are unsympathetic to the use of detachable bits that only a large company can afford the plant necessary to make a detachable bit. Then their attention may well be directed to bits that can be purchased ready-made, as one buys other hardware. Many types of detachable bits are now available, some of which have responded to performance tests in a manner that demonstrates the practicability and economy of the detachability principle.

Anaconda Copper is more than satisfied with the performance of the Hawkesworth bit, according to advices received from company officials in Butte. Both from the viewpoint of lowered drilling costs and increased efficiency in breaking rock, its use, they declare, has exceeded expectations. In 1929, when production exceeded one million pounds of copper per day, Anaconda's mines were completely equipped with Hawkesworth shanks and bits; and all of the hundreds of thousands of drill holes required to break the rock for this output were drilled exclusively with these bits. To return to the old-style drill steel would, they say, be a step backward, which would work hardship on every underground employee, from station tender to miner, to say nothing of the sacrifice in efficiency and costs which would result. No such move has ever been contemplated.

Here, at least, is one mining company that regards use of the familiar one-piece drill steel as old-fashioned.

Technologic Advance Passes in Review

"WERE WE REQUIRED to characterize this age of ours by any single epithet, we should be tempted to call it the mechanical age. It is the age of machinery, the age which, with its whole undivided might, forwards, teaches, and practices the great art of adapting means to ends. Nothing is now done directly, or by hand; all is by rule and calculated contrivance. For the simplest operation, some helps and accompaniments, some cunning abbreviating process is in readiness. Our old modes of exertion are all discredited and thrown aside. On every hand the living artisan is driven from his workshop, to make room for the speedier, inanimate one. There is no end to machinery." The foregoing might have been written in 1933, but it came from the pen of Thomas Carlyle and was published almost exactly one hundred years ago.

The use of machinery was in its infancy early in the nineteenth century, but the impression produced by technological innovation even then was profound. Misgivings followed: "What changes, too," continues Carlyle, "this addition of power is introducing into the social system; how wealth has increased, and at the same time gathered itself more and more into masses, strangely altering the old relations, and increasing the distance between the rich and poor, will be a question for political economists, and a much more complex and important one than they have yet engaged with."

The prescience of Carlyle found no general reflection or acceptance among economists, political or otherwise. No social hazard in the wider use of machinery was recognized outside a small group of thinkers. The

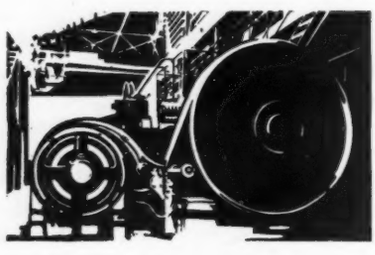
sponsors of the machine paid no heed to a morrow in which human idleness, with its palsied purchasing power, might force the machine also to cease work. Invention and technical advance continued to expand, serving as a convenient tool to create new wealth, to advance social and industrial life, to bring convenience and comfort. A quarter of a century after Carlyle had written with such prophetic insight one finds evidence of growing recognition of an unhealthy stimulus to acquire easy money, to become rich quickly—a condition antecedent to every instance on record of economic disequilibrium and national depression. An editorial in *Harper's Weekly* published 75 years ago reflects conditions almost exactly as they are today: "Of our own troubles no man can see the end," said the editor. "They are, fortunately, as yet mainly commercial; and if we are only to lose money and by painful poverty to be taught wisdom—the wisdom of honor, faith, of sympathy and of charity—no man need seriously despair. And yet the very haste to be rich which is the occasion of this widespread calamity has also tended to destroy the moral forces with which we are to resist and subdue the calamity."

In 1857 the effect of the American depression was felt in Europe mostly by those who had speculated in the United States railroads—illustrating an early large-scale use of mechanical invention as a factor in the concentration of wealth. Recriminations came west. Brother Jonathan was accused of swindling trustful Europeans; but in the same issue of *Harper's Weekly* in which avarice on the American side of the Atlantic was condemned may be found a reproof that "John Bull and his neighbors on the Continent have been so ravenous for eight and ten per cent interest that they have rushed into American securities without exercising common prudence."

In the present depression the world is again contemplating the ashes of financial desire, of the swelling of a credit bubble to bursting point, of a trust in a leadership that sought vast profits in the flotation of loans and the boosting of stocks—of securities and products, in the incorporation of companies and the camouflage of financial facts. Acquisition born of greed knows nothing of prudence.

Human Factors and The Machine Age

ON ANOTHER PAGE of this issue appears a review of a report by a commission appointed by President Hoover on "Recent Social Trends," containing a conclusion, apparently reached unanimously by all the members of a large group of investigators, that concentrates attention on "the stark and bitter realities of the social situation," and "the imminent perils in the further advance of our heavy technical machinery over crumbling roads and shaking bridges." The disparity between wealth and poverty, anticipated by Carlyle in 1832 as the inevitable sequel to the introduction of a machine economy, has grown; and the report now issued compares "the splendid technical efficiency of some incredible skyscraper and the monstrous backwardness in some equally incredible slum." The incidence to technological unemployment by increasing invention is recognized, bringing into sharp focus the need for social readjustment. The authors of the monograph on "Invention" admit that "There seems to be no way of measuring the future of this displacement. But there are so many new inventions indicating displacement of labor that technological unemployment may be an even more serious problem in the near future than it is now. In the past, expanding industries and population shifts have in time accomplished the readjustments. It is difficult to say whether these numerous new labor-saving inventions may not augment the problem of technological unemployment, but such is a strong possibility."



No good can come, no escape from existing conditions is possible, by praising or by damning the machine. It is here—to stay. Its sphere of control increases daily, but its encroachments on human labor are so gradual that they attract attention only when social conditions become acute. Most intelligent observers have recognized that a labor-saving machine reduces personnel, but the tremendous effect of technological advance in the last three years was not brought to the public consciousness until a group of investigators, who had occupied themselves in an energy survey of North America, made a preliminary report of their findings in August, 1932, in which the contention was advanced that, assuming a return to the conditions of commercial activity prevailing in the greatest boom year in the history of the United States, only about 50 per cent of its present large army of jobless could be given employment—a thesis that has since been repeated, without contradiction, by writers of all shades of political opinion, by candidates for public office, by educators and economists and clerics.

Some professional publicists have decried and ridiculed the contention that mechanization creates unemployment, and affirm repeatedly that labor-saving machines make more jobs than they displace. Such arguments are easily refuted. As *Engineering and Mining Journal* averred in discussing this subject a few months ago: "Technologic change effected by substituting the machine for hand labor may not cause immediate unemployment; but it undoubtedly creates a hazard that has materialized into a serious and menacing problem in recent years, a contributory cause to general depression." No adequate corrective has been applied; self-interest and complacency apparently prevent the application of any remedial proposal from coming within the range of practical politics.

To argue that technological unemployment can be remedied by increased invention ignores the status quo, for we are passing through the greatest period of inventive ingenuity ever known, as the records of the Patent Office prove—an expansion of initiative so great that the Government of the United States, while purporting to foster technical advance, erects obstacles to discourage the private inventor, by drastic upward revision of patent-application and issuance fees; despite the fact that the patent office returns a profit to the Government with normal charges. The burden of the extra expense,

of course, falls on what is contemptuously termed the "garret inventor"—the lone worker with initiative but without resources, usually out of regular employment, and ill equipped financially to contend against the advances of the heavily subsidized research laboratories and the decisions of that close-knit coterie of members of the legal profession that is gradually assuming control of the civil process of patent application and prosecution to issuance.

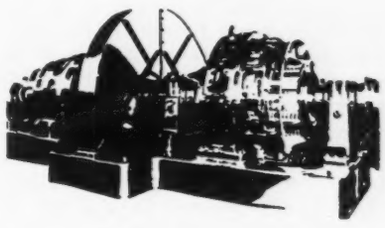
Nor are those who proclaim their satisfaction with the prevailing system of compensation and reward entitled to repeat with such disdain of fact that as the dominance of the machine has increased so have the hours of labor been reduced—crediting the promotor of machine enterprise with a fine sensitiveness that makes him shrink from inflicting on common humanity the drudgery of manual labor. The average hours of work have been reduced, but not to an extent commensurate with the need indicated by the unemployment caused as a direct result of the encroachment of machines in the labor market. A scientific attempt to allocate to the machine its measure of responsibility as a factor in the present grave sociological situation cannot be dismissed by ridicule, sarcasm, or satirical publicity. Perhaps the time is not appropriate to suggest that those who initiate and direct technical enterprise are better equipped than is any other group of society to effect a reform, but the sentiment is growing that neither in business nor in political circles may be found the intellectual freedom that will express itself in some plan to restore employment on an extensive scale, and thus increase the consuming power of the masses, or to remove most of the unemployed from the labor market as well as from dependence on charity—the only two alternatives to a continuance of economic instability.

Technical Expansion And the Debt Burden

IF unemployment and unemployability were the only problems facing the world today their solution would not present insurmountable difficulties. But a consensus of opinion is reaching agreement that the extent to which financial indebtedness has permeated into every branch of government, into almost every industry except that of central banking, into almost every home, has made readjustment impossible without a lifting of the load. Sober judgment is reducing the valuation of claims made about the so-called high standard of living during the boom period, of which automobile production is taken as the statistical symbol. The alleged superiority in status was attained to a considerable extent, as the facts indicate, by incurring debt and by mortgaging the future on the strength of a promised prosperity that failed to materialize. And a similarity is traceable between the non-technical publicist who rushes to the defense of the machine in gratuitous fashion—with the claim that technologic unemployment caused by the introduction of labor-saving devices can be remedied by the invention and production of more labor-saving devices—and the soothing appeals of finance companies to worried debtors that accumulated financial obligations can be pleasantly forgotten by their temporary settlement from a loan obtained to cover the total amount. In each instance the day of reckoning is merely being postponed. Debts may never be paid—most existing debts probably will not be paid—but the prospect that employment may diminish almost to a vanishing point should not be accepted with equanimity or indifference.

A heartening and encouraging sign of the times is that public opinion has at last become aroused by a realization of facts, and no serious import should be attached to the objection that the work of any agency is to be decried because it assembles data but fails at the same time to propose a solution of all the business and economic ills that torment and threaten the world. Most prosperity-restoration plans have failed because they revealed too much evidence of an unenlightened self-interest and too little evidence of expert and impartial diagnosis of the underlying causes of the economic *malaise*. They elicited inadequate cooperation and support in consequence; their sponsors have been too prone to deflect attention from existing conditions by reference to cyclic repetitions of trends in the past that have failed to reveal the steady dissociation that has been taking place between techno-financial success and social responsibility.

The time has come to insist that government and industry recognize their obligation to society as a whole, and seek to promote the greatest good for the greatest number. Both should scorn an attitude that can be interpreted as insincere; otherwise the operation of an economic reform may be nullified by the exercise of a personal selfishness born of distrust of present policies and influenced by fear of the future. Meanwhile, the victims of economic disequilibrium may find solace in the thought that fundamental problems have reached a stage when a solution is being demanded, that society is aroused, and that a plan more fundamentally sound is being sought than the borrowing of more money to meet the debts incurred by a deluded people and an irresponsible policy of expansion by government and industry during an era of riotous expenditure. So far as the influence of the machine on social economics is concerned, the facts disclosed in recent months are disturbing. The significance of the changes that have occurred, particularly since the interruption to credit expansion in 1929, need evaluation. This work is to be undertaken. The general effect of recent technologic advance, particularly as manifested in mass production, will be studied by a commission, of a membership mostly academic, appointed by President Nicholas Murray Butler, of Columbia University; and also by a committee of practicing engineers, with Mr. Walter N. Polakov as chairman, appointed by Mr. John M. Carmody, president of the Society of Industrial Engineers. Those who have the well-being of all classes of society at heart hope and expect that the resultant reports will be characterized by sincerity and fearlessness, and by a concern for all the elements of a society that has been led too easily, by plausible debaters and by propaganda, into hostile camps of divergent opinion.



Determination of Oreshoot Bottoms

Harrison Schmitt

THE subject of the bottoming of oreshoots is of predominant concern to the mine operator when he seems to have reached the downward end of his ore. He wishes to know if the pinching is true or apparent, and whether or not he should risk sinking the shaft another level, possibly against large volumes of water. That a problem usually so critical should be so difficult is unfortunate, but the best efforts of the mining geologist are therefore challenged. It seems worthy of a program of organized research.

This paper presents descriptions of the bottoms of several ore deposits studied by me in northern Mexico and in the Southwestern United States, concluding with tentative generalizations.

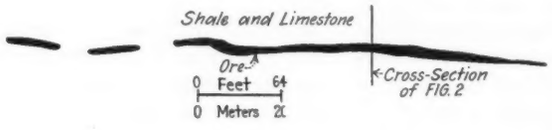


Fig. 1—Plan of second level, La Hundida mine, Santa Barbara district, Chihuahua. Shows lenslike horizontal section of the root of the main oreshoot.

The oreshoots at Santa Barbara, Chih., Mexico, have been described by Spurr[4] and Schmitt[7]. Within the last six years two different types of bottoms have been reached in the district. One was found between the 8th and 10th levels of the Hidalgo mine south of Arroyo de las Vacas, where the average ore above the 8th level had approximately the following composition: Quartz, 60 per cent by weight; fluorite, 15; galena, 12; sphalerite, 10; chalcopyrite, 2; arsenopyrite, less than 1 per cent. A specimen selected as typical, from the 10th level, when examined with the microscope showed the following approximate composition: Quartz, 85 per cent by weight; fluorite, 10; pyrite, 2; chalcopyrite, less than 1; sphalerite, less than 1; galena, less than 0.1; arsenopyrite, less than 0.1 per cent. Minor primary carbonate was also found, associated with the quartz. Apparently the essential change is increase in quartz, decrease in sulphides, and appearance of primary carbonate. But for this latter *quality* change, the bottoming of the shoot could be assigned to lack of sufficient brecciation (Bain[6]; Hulin[6]) of the early barren quartz, and lack of sufficient openings for the deposition of commercial quantities of the sulphides. But the carbonate is probably indicative of a more fundamental change, unless it also existed in the upper part of the shoot and was replaced by the later metallic minerals.

Another type of bottom reached in the same district with more definite indications than the one just described is about 50 meters (160 ft.) below the surface in La Hundida mine, about 1 km. (0.6 mile) south of San Francisco del Oro. This seems to be a true bottom, for fundamental changes occur downward. Near the outcrop the shoot is similar to the Hidalgo vein above the 8th level; but the lead decreases rapidly downward, and the conditions on the lowest level are shown by Figs. 1 and 2. Here the minerals are coarse textured, with sphalerite and a few galena crystals up to 6 in. diameter, and chalcopyrite up to 2 in. diameter in stringers that cut coarse calcite and quartz (Fig. 2) and that contain no admixed gangue. The vein at this place is analogous to a pegmatite from the standpoint of grain size. The sulphide stringers characteristically appear lenslike in plan (Fig. 1), but rootlike in longitudinal vertical projection.

A variation of this second type of bottom was reached at the 12th level of the San Albino vein at Santa Barbara, according to T. P. Clendenin, where the sides of the vein are composed of coarse pyroxene and other silicates, and the center is of coarse sulphides. The minerals were much finer grained above this level.

The resemblance of the texture of these bottoms to that of pegmatites is suggestive, particularly because orthoclase—with quartz, calcite, and silicates such as pyroxene and garnet—is found in veins in this district (Schmitt[7]). The geneticists seem to have a possible case here of a connection of veins with pegmatites. No granitoid intrusive is known in the vicinity of the veins.

The majority of the known oreshoots of the Parral district of Chihuahua, Mexico, except a few in the vicinity of the city of Parral, have been explored to and below their bottoms, so much information about them is available. They seldom extend below an elevation of 1,700 meters (5,450 ft., sea-level datum), according to John Barry, which means 50 to 300 meters (160 to 960 ft.) below their outcrops. They have the form of V's, and bottom in one or more roots (Fig. 3 and Schmitt,[7] pp. 284-85), which appear lenticular in plan on the 5½ and 6 levels of the Sierra Plata mine (Fig. 4), and on the lower levels of the Plata Verde mine, and are enclosed by a gangue of silicified breccia. At places in the Plata Verde mine, development below the silicification and sulphide roots disclosed a coarse unmineralized breccia the interspaces of which are voids. This mine made over 3,000 g.p.m. of water, and loose filling, such as gouge, in the interstices, may have been washed out with the rush of the water when the level was opened. I was told that the change, from massive silicified vein with sulphides to this breccia, took place within a few meters. The fluorite gangue was coarser at the bottom of the mineralized section. This breaking up into roots and change of mineral character in the Sierra Plata and Plata Verde shoots, I believe, represents a true bottom. The root of the Palmilla oreshoot (Fig. 3) on the 7th level showed a horizontal section of silicified rock about 50 meters (160 ft.) diameter, cut by veinlets of sulphides up to 3 cm. wide. The diminution in size, structural relationships, and change in character of this root also indicate a true bottom.

It was previously stated (Schmitt,[8] p. 283) that the shoots of the district show an increase in lead and zinc in depth. This may not represent a hypogene condition, for much zinc was leached out in the near surface zone; and in the early days the silver-rich lead may have been selectively mined near the outcrop. But if the down-

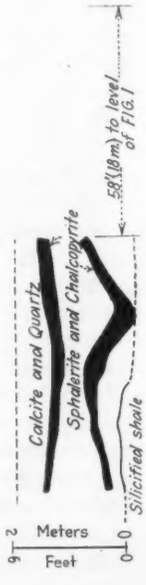


Fig. 2—Cross-section of La Hundida vein at the bottom of the main oreshoot, Santa Barbara district, Chihuahua. Shows the structure of the pegmatite-like root.

ward increase in base metals does represent a hypogene condition, it is evidence of approach of the bottom of the shoots.

Summarizing, evidence indicating bottoming of shoots in the Parral district includes: (1) diminution in size and tendency to extend downward as roots; (2) position relative to the 1,700 meters (5,450 ft.) above-sea-level elevation; (3) change to coarse fluorite; (4) change to unmineralized breccia; (5) increase in lead and zinc.

Most of the sphalerite ore at Hanover, N. M., occurs as replacement bodies localized by fissures that cut a 120-ft. white, pure crinoidal limestone bed near the contact of an intrusive "stock," and is associated with andradite, hedenbergite, and other silicates. An 18-ft. shale bed superjacent to the crinoidal limestone appears to have acted as an "impervious" bed, because the ore in many places spreads out

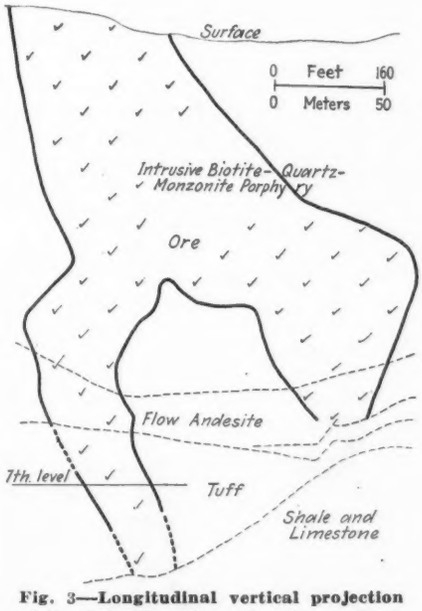


Fig. 3—Longitudinal vertical projection of the Palmilla vein and main oreshoot. Parral district, Chihuahua. After F. W. Smith.

along its lower contact. A 200-ft. gray limestone bed, 200 ft. of fissile shale, and finally a thick series of dolomites and magnesian limestones occur in succession below the crinoidal limestone.

The largest of the oreshoots in the crinoidal limestone, particularly when localized by crosscutting faults, and when extending downward through the entire 120-ft. section, have a bottom of sphalerite (6 to 10 per cent Zn) in the 200-ft. gray limestone. Here the sphalerite and associated gangue silicates have a much finer grain, apparently caused by the finer texture of the host rock. When the localizing fissures are followed downward still farther, through and below the 200-ft. shale, they are found to contain pyrite with no sphalerite. This is believed to represent a fundamental change and

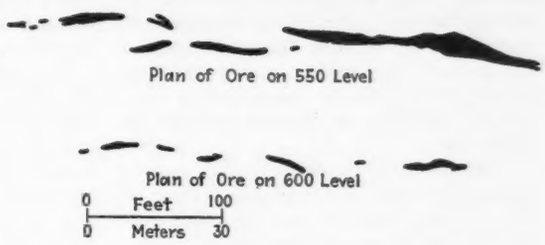


Fig. 4—Plan of the bottom levels of Sierra Plata oreshoot on the sixth level, Parral district, Chihuahua.

to indicate the true bottom of the zinc ore.

The characteristics of bottoming of the manto-chimney type of deposit within the area selected for this discussion are unique and should be mentioned. The downward and lateral connection of the mantos with chimneys at Erupcion-Ahumada and Santa Eulalia, Chihuahua, and at Gilman, Colo., seems to present an indication of value, because no extension has ever been found below the bottoms of the chimneys. Moreover, the change from manto to chimney is commonly accompanied by a mineralization change. For example, at Erupcion-Ahumada, Chihuahua, the oxidized lead mineralization of the manto becomes high in vanadium and molybdenum minerals (vanadinite, descloizite, and wulfenite) when it connects with and turns down into the chimney. At Santa Eulalia, Chihuahua, the iron silicates first appear in the bottom of the Mina Vieja chimney; and at Gilman, Colo., the chimneys are of massive pyrite, with minor chalcopyrite and tetrahedrite, whereas the connected mantos carry oxidized and unoxidized lead and zinc minerals. In this connection it is interesting to note that the lead-zinc sulphide replacement orebodies in the upper levels of the Nitt mine, Magdalena district, N. M., turn to roots of massive pyritic copper ore in depth and pinch out quickly downward, although the distinctive manto-chimney form is not developed there.

Silver-manganese-quartz deposits below the Devonian Percha shale in southwestern New Mexico have been described (Lindgren,[10]). The ore is localized by fissures that cut the shale and replace the magnesian limestone just under the shale; it never extends more than 100 ft. below the contact. The topography is rugged in the six districts that exemplify this type; and, although no ore outcrops in the limestone beds exposed for hundreds of feet stratigraphically below the shale, fruitless deep development has still been done on the ore-bearing fissures, with the idea that they are veins. If no deep development had been done at all, it should have been obvious from a statistical point of view that the fissure ore would die out within ± 100 ft. below the shale contact.

The "funnel" ore of Utah and Nevada, described to me by Augustus Locke and Paul Billingsley, seems to be a distinct type. It is well developed at Tintic, Park City, Ely, and Eureka, and has affiliations with the manto-chimney type; indeed, it merges with the latter and similarly is essentially the convergence downward of horizontal elements into a vertical element. The convergence is funnel-like, and not marked by a sharp break from manto to chimney. This is probably explained by the fact that the true manto-chimneys occur in flat-lying massive undisturbed limestones, whereas the "funnel" is found characteristically in intensely thrust folded and faulted zones. Many of the "funnels" bottom in coarse breccias, and this phenomenon appears to be an important indication of bottom, along with mineral changes such as a decrease in base-metal content.

A distinction should be made between the true and the apparent bottoms of oreshoots. The apparent bottom may have no more significance than the ending of a shoot horizontally, and should show no fundamental mineral change. Similar shoots may exist below. The true bottom is critical, and represents the change from ore stability to non-stability. How may these types be distinguished?

Our present knowledge suggests that, in the province under discussion, the position of ore in relation to the surface of the earth is the product of three factors: (1) position of ground preparation in relation to the surface of the earth; (2) position of the zone of ore precipitation in relation to the surface of the earth; and (3) effect of erratic chemically and/or texturally reactive bodies on ore precipitation. In other words, given a crosscutting structure—such as a fault, fracture, dike contact, intrusive contact, breccia chimney, or breccia cone—the locus of the ore depends on the vertical range along this structure in which the normal factors of temperature, pressure, and concentration exert an ore-precipitating effect.

Therefore, if the zone of the factors that exert a positive action on ore deposition (zone of precipitation) is higher than the bottom of a given fault or mass of breccia (zone of ground preparation), the ore will end downward in unmineralized broken ground, and will have a true bottom such as has been described. If the zone of precipitation is lower than the zone of ground preparation, the ore will end downward

without fundamental mineral change, and will have an apparent bottom. In the second case, prediction usually must be indefinite, because the possibility of the ground opening up again in depth is usually indefinite; in the first case, we may be able to develop reliable indications.

The problem is complicated by the possibility that the stability zones of the gangue minerals may be higher or lower than those of the ore minerals; and still more complicated when the gangue minerals, particularly quartz or silicates, are older than the ore minerals. In this circumstance the introduction of the ore minerals must be preceded by shattering, unless the openings were not previously completely filled by the gangue. Therefore, if the evidence indicates the succession: early quartz, shattering, and ore minerals, the early gangue is literally wall rock, and the shattering and ore mineralization are the immediate factors to consider.

At this point the problems of structure deserve attention. Experience indicates that the chances are fewer than one in twenty that a given oreshoot will extend more than 2,000 ft. (Hoover,[1] p. 32) vertically below the surface; and, say, one in a thousand that it will extend more than 5,000 ft. Hoover says (p. 31) that the average ratio of outcrop length to depth for a large number of veins is near 2 : 1 and calculations by Schmitt (*, p. 324) indicate that this ratio is the average of eight important veins in Utah. Observation suggests that the broken ground in many mineralized districts decreases in form and rate comparable to a cone whose sides converge at 45 deg. Many hanging-wall fracture systems, "funnel" systems, and so-called stocks converge downward at about this rate. The normal section of this hypothetical cone would have a ratio of base to depth of 2 : 1—Hoover's ratio for oreshoots or ore zones in veins. This suggests that, on the average, oreshoot extension in depth may be closely related to the depth of preparation of the ground.

The many factors that may cause ground preparation to depart from the ideal downward diminution just outlined include those that tend to cause horizontal restriction, such as vertically fractured, faulted, or schistose rocks, or any vertical structural expression, and those that cause horizontal expansion, such as massive horizontal limestones, unconformities, impervious beds, and thrust faults. A critical plane commonly present in the West is the contact between the basement, in which the vertical factors are likely to predominate, and the higher disturbed or undisturbed bedded rocks. This plane often marks the bottom of a manto-chimney or funnel system.

So much for the broad relationships of structure to depth extension. When a specific orebody or vein is under consideration, reliable relationship between outcrop length or area and depth is obviously not known, except possibly such as may be determined and applied in a given district. For some districts a level below which few orebodies extend may be ascertained. Such broader data all enter into and strengthen assumptions or speculations as to the bottom of a shoot. Probable definite indications for true bottoms include: (1) unmineralized pre-ore breccia extending below ore; (2) coarsening of texture of gangue and ore minerals up to that of a pegmatite; (3) gradation of ore minerals to contemporaneous gangue minerals; (4) change to chimney form in the manto-chimney or related deposits, especially if accompanied by a change of mineralization, particularly from base-metal sulphides to pyrite or iron silicates; (5) tapering of orebodies to distinct roots; this usually must be judged with other evidence. Unreliable indications (they suggest a chance for new ore below) include: (1) pinch in ore without textural or mineral changes; (2) change from ore to pre-ore mineral gangue; (3) changes of the zoning type; these can sometimes be judged, however, by the horizontal zoning.

■

Acknowledgment

I am greatly indebted to F. F. Grout and Augustus Locke for criticism of the manuscript of this paper.

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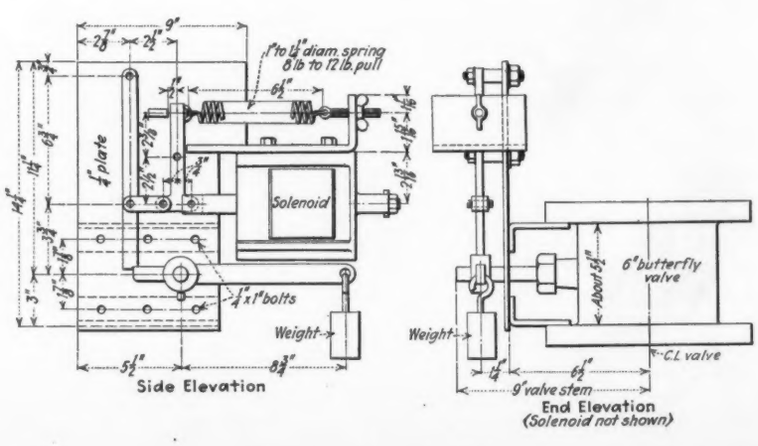
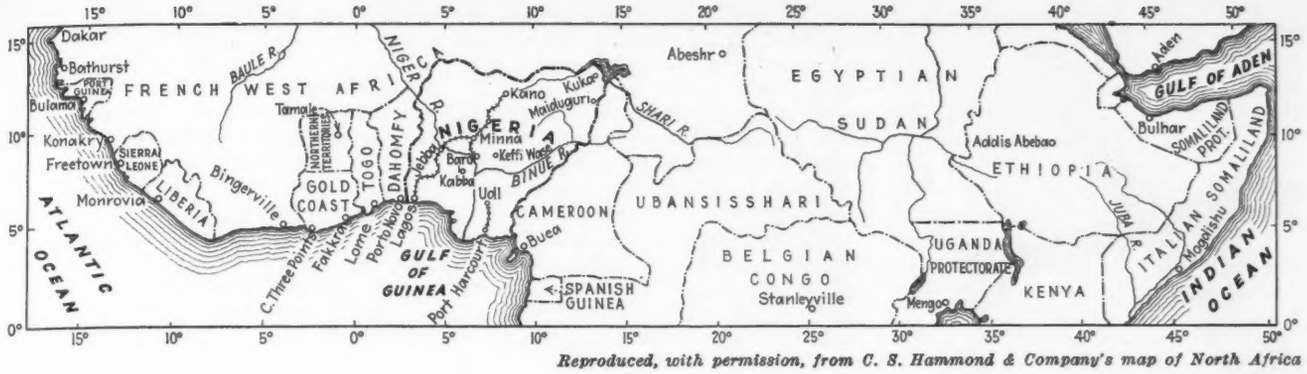
Automatic Gas Valve Reduces Hazard

SIMPLICITY of construction and rapid performance are the outstanding features of a relay-controlled safety device developed recently by the mechanical department of the Copper Queen Branch of Phelps Dodge Corporation, at Warren, Ariz. The contrivance is built into the main gas lines leading to the burners of the boilers at the Junction power house, to prevent an explosion should a shortage of air occur. It consists of a 6-in. Crane butterfly valve operated by a 440-volt Cutler-Hammer solenoid connected to the circuit of the 440-volt motor driving the forced-draft fan. When the solenoid is energized, the valve is opened and held in that position by the latch equipped with a counterweight and secured to the valve stem, as illustrated. With no power in the circuit, the solenoid is instantly de-energized, and a spring releases the latch, which is pulled down by the counterweight, thus automatically shutting off the supply of gas to the burners.





Reproduced, with permission, from C. S. Hammond & Company's map of North Africa

Tin Placer Mining in Nigeria

W. E. Sinclair

APART from the wide variation that normally occurs in the physical characteristics of placer deposits, the geological history of the Nigerian tin field is somewhat complicated, as shown by the description outlined by the Nigerian Geological Survey (A. F. Skerl: *Min. Mag.*, April, 1932):

1. Intrusion of Younger Granite into a series of metamorphic rocks already intruded by Older Granites.

2. Mineralization of the Younger Granite and the adjacent older rocks, more especially at the crown of the batholith.

3. Erosion of the whole series, with deposition of tinstone in a drainage system that became buried under a series of alluvial, volcanic, and eluvial accumulation, termed the Fluvio-Volcanic series.

4. Elevation of the plateau portion of the granite batholith and renewed erosion of the granite and the Fluvio-Volcanic series, with re-deposition of tinstone along new drainage lines.

5. Recent lava flows covering large areas of the plateau.

Secondary enrichment has resulted in many of the deposits on the plateau, as a result of the re-deposition of tinstone in a later age. Deposits lying at a lower elevation and off the plateau do not share in this enrichment. Hence, the plateau deposits are the more important.

The ground comprising the placer deposits, covering the plains and valleys and converging onto the river zones, consists essentially of cemented sands and clay—an accumulation resulting from erosion of solid rocks by rain and wind and decomposition. In some places the basalt covering or overburden is weathered to a tenacious clay, extremely hard and tough when dry but sticky when wet, treacherous and difficult to handle. Depth of overburden covering the tin-bearing ground varies from a few feet to as much as 100 ft. When the tin occurs on the bottom three or four feet of the total depth, this zone or layer is known as the "wash." It occurs generally on a decomposed granite bedrock, although on occasion a hard granite appears to constitute the bottom. The characteristics of the wash may be summarized as (1) a hard, cemented gravel mixture; (2) gravels and sand, with bands of hard or tough clay; (3) cemented gravels with a capping or layer of extremely hard laterite.

The cassiterite in some deposits is not concentrated on the bottom, to form the wash, but occurs distributed throughout the whole depth of the ground. This is generally the case in those deposits related to the present river system and situated in the present river beds or adjoining valleys.

Classification of the Nigerian deposits relative to the geographical features of the country has been arranged by W. C. Grummitt (*Min. Mag.*, June, 1932) as:

1. *Watershed Deposits*—(*a*) detrital; (*b*) alluvial; (*c*) Fluvio-Volcanic series.

2. *Valley Slope Deposits*—(*a*) detrital; (*b*) high terraces; (*c*) old tributaries; (*d*) Fluvio-Volcanic.

3. *River Deposits*—(*a*) in present stream bed; (*b*) low terraces; (*c*) valley flats, bedrock below present river level; (*d*) recent gravels.

Geographically, the Nigerian Plateau, situated in the northern territories of the colony, consists of undulating grassy plains, dotted with granite hills or outcrops. The valleys that cut the plains and drain the watersheds constitute the sources of several large rivers, although many of the beds are almost dry during six months of the year, but may rise to flood force during the period of tropical rains. The plateau, which has an average altitude of 4,000 ft. above sea level, experiences two distinct seasons during the year—the "dry" season from November to April, when rain is rare; and the "wet" season from May to October, when the average rainfall is about 50 in. Half the rain falls during tropical storms and consequently flows away as flood water. Because of the geographical nature of the country it is difficult to catch and conserve without heavy capital outlay.

The most satisfactory method of placer mining of the deposits under normal conditions has for long been a theme of interesting controversy among engineers. Much low-cost production on a small scale has been accomplished, with the assistance of the local native laborer, by ground-sluicing methods, on deposits suitably located in regard to available water supply and tailing disposal. Shortage of water in the dry season, or the unsuitability of the deposit in relation to the present drainage system, has handicapped successful large-scale operations by this method.

Native labor is fairly plentiful in Nigeria, although a seasonal shortage is felt by mines depending on it entirely. Native-labor wages vary from one shilling to two shillings per day. As is often the condition with "cheap labor," it is usually inefficient labor, and not economical. Where manual labor is necessary in the tropics, however, the native is able to work under conditions the average white man is unable to stand. Output of the laborer is rarely more than one-fifth of that of the European. In terms of volume it amounts to from 3 to 4 cu.yd. per shift excavated and shoveled back without haul. Mechanical methods are sometimes adopted, to save labor and to stabilize production. Under ideal conditions, however, overburden averaging

Fig. 1—Steam shovel lowering 90-hp. portable boiler and engine into the pit

12 ft. deep has been stripped by hand-labor ground sluicing, on contract, at a cost of 1.9 pence per cubic yard, the output per man averaging 10.4 cu.yd. per shift.

Ground sluicing methods are economical when gravel pumps or jet elevators are used. Other hand excavating methods without the aid of water tend to make the cost of gravel pumping excessive. Also, pumping water to monitors for hydraulicking is too expensive when broken ground and water must be elevated out of a paddock. To elevate gravel under the conditions found in Nigeria, pumps are favored to a large extent, being portable and economical in water consumption. With this class of plant, where water is scarce, only sufficient make-up water need be added to counterbalance loss by evaporation and absorption. Gravel pumps, under certain conditions mounted on pontoons, have proved extremely successful, even at the present low price of tin. These pumps involve a comparatively small capital outlay, but maintenance and running repairs and replacement of spare parts, such as liners and impellers, are a heavy charge on working costs, amounting to as much as 1.25 pence per cubic yard.

The total average cost of pumping depends mainly on the cost of breaking ground and the delivery of the ground to the pump sump; and without these charges averages from 6 pence to 9 pence per cubic yard. A typical example of production costs, in pence per cubic yard, of tin winning with the aid of a gravel pump is as follows: Native wages, 7.60; white supervision, 3.00; stores, 1.56; other charges, 0.86; total, 13.02 pence. Charges for breaking ground are included under "native wages"; maintenance costs are included under "stores."

Another example of the high cost of breaking ground by hand labor is illustrated in the following production costs, also in pence per cubic yard, where a jet elevator is used to convey gravel to the sluice boxes: native wages, 7.14; white supervision, 2.78; stores, 0.41; other charges, 0.72; total, 11.05 pence.

A form of underground mining, known locally as "loto" work, has been introduced on deep deposits where the tin is concentrated on the botton three feet of the ground. The method is a form of drift mining, approached by means of several pits, sunk on a system of squares at fairly close intervals. The efficient layout of drifts is simplified by placing pits as close as is economically possible. Length of haul underground is thereby reduced, but the total cost of the method is increased because of the cost of the large number of pits sunk. Wash is hoisted through the pits by means of hand windlass. "Loto" work is economical in water consumption, but it requires a large labor force for yardage handled and gives a comparatively poor recovery; the treacherous nature of the ground in the majority of the deposits calls for a system of drifting in parallel lines, longitudinally and transversely, leaving pillars 4 ft. square between drifts, which often means a loss of 40 per cent of the deposit. On an uneven bottom, the drainage of drifts presents a difficult problem, and causes a serious loss by spillage of concentrate, which is likely to be trodden into the decomposed granite bedrock.

Costs in this class of work are usually based on the weight of 70 per cent tin concentrate recovered, not on cubic yards extracted or on feet driven. They vary considerably, therefore, depending mainly on the value of the ground. A great advantage in this system of mining deep leads is that a quick return with small capital expenditure is possible, if conditions are suitable.

Other methods of handling ground that are common practice in other parts of the world are utilized to a small extent in Nigeria. The nature of the country and of the deposits, and the scarcity of water at certain times, have limited the extensive use of dredging, hydraulicking, and jet elevating. The following disadvantages are apparent:

1. The ground is too clayey for bucket dredging, and possibly too hard and tough for efficient ground sluicing by hand.

2. Deposits possess bedrock at a lower elevation than the present river system, preventing drainage of the workings or disposing of the tailing without the aid of elevators or pumps.

3. Deposits are related to the present river system and in the river bed.

4. Water is available in insufficient quantity and insufficient head for efficient hydraulic pressure.

5. Nature of the country is such that cost of water conservation necessary for all-year working is too costly.

6. Contours of the surface are too flat for grades necessary to secure sufficient head of water, or for the disposal of tailing by gravity.

Dredging and drift mining, or "loto" work, in Nigeria, permit low cost production under normal conditions, but the operation usually results in a low recovery of tin, about 30 per cent of the reserves being left in the ground. This inefficient recovery is apparent in the open-cast workings to be seen on ground previously dredged or mined by drifts in Nigeria, and on placer fields in other parts of the world.

Excavating With Shovels.—The unsatisfactory conditions outlined in the foregoing were responsible for the in-

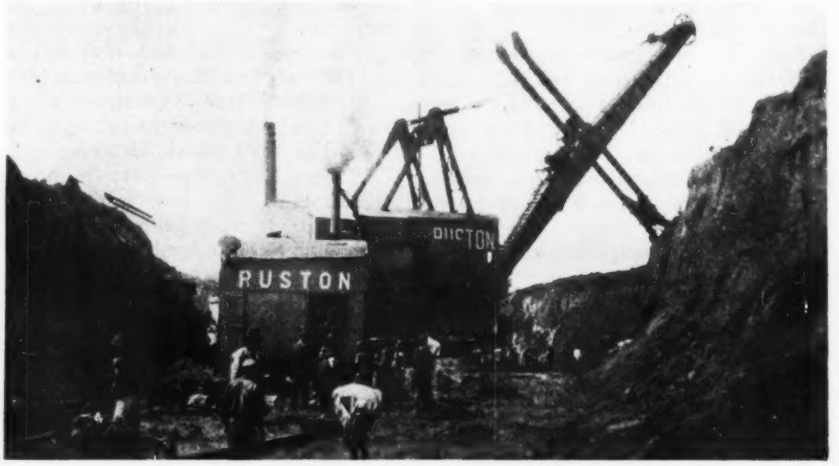


Fig. 2—Stripping shovel with 6-yd. bucket opening up pilot cut, followed by shovel with 3-yd. bucket, for excavating wash

Fig. 4—View of cut, showing wash removed and bench of wash left alongside bank for return track of stripping shovel

troduction of shovels and draglines in the Nigerian tin field, to break ground and strip overburden on the larger deposits. The stripping of deep deposits, to expose the wash, reduced by 90 per cent the quantity of water required, only sufficient being needed to deal with the tin-bearing wash, which represents about 10 per cent of the total—an important consideration on a field where water is not plentiful.

One example I have already described ("Steam-Shovel Mining in Nigeria," Inst. Min. & Met. bulletin, May, 1930) of the exploitation of a deposit averaging 50 ft. long represents a successful application of the large revolving shovel in this class of mining. A 300-ton revolving stripping shovel, with a 6-cu.yd. bucket, was followed by a smaller shovel with $\frac{7}{8}$-yd. dipper, mounted on caterpillars, used to excavate and load the wash exposed by the stripping. Gravel pumping plants at each end of the cut elevated the wash to the sluice boxes on the bank. Fig. 1 shows the stripping shovel lowering a 90-hp. portable boiler and engine, to be used for driving one of the gravel pumps, into the cut. Other equipment and plant was as follows:

Machine Shop: 25-hp. horizontal oil engine.

Tin-Dressing Plant: 5-hp. engine driving a 2-in. centrifugal pump for water supply.

Lighting: Vertical boiler to supply steam for a 10-hp. vertical high-speed engine driving a 6-kw. generator.

Water Circulation: 80-hp. horizontal oil engine driving an 8-in. centrifugal pump, delivering water a total head of 47 ft. a distance of 800 ft.

Fig. 2 shows the shovels in the cut, with tracks and trucks in the foreground preparatory to laying of track ready for trucking back the wash. Work proceeds along the length of the deposit in a series of cuts, the muck excavated by the stripping shovel being dumped back into the previous cut from which the wash has already been recovered. Fig. 3 is a transverse section of the cut, showing stripping shovel, working face, and dump. The shovel is shown with booms of varying lengths, to illustrate the decided dumping advantage of the longer boom in deep ground, and the maximum working depth in each operation.

The stripping shovel in the operation here described excavated and dumped an average of 17 cu.yd. to expose 1 cu.yd. of wash, and yet the work kept well ahead of the smaller shovel following on the wash. Fig. 4 is a view along the length of the cut, showing area of wash removed flooded with water. The bench of wash left in alongside the bank is for the return track of the stripping shovel on the next cut. The small shovel delivered the wash into 1-cu.yd. side-tipping trucks, which were hauled by gasoline locomotive to the end of the cut, where the wash was dumped into a sluice of running water, used to break up the gravel and clay and to convey the mixture to the gravel pump sump. An 8-in. gravel pump, operated by a 90-hp. steam engine, elevated the gravel mixture 65 ft. to the sluice boxes on the top of the bank, where, after sluicing and washing, the concentrate was recovered and trammed to the dressing plant for final cleaning and bagging.

Average cost, in pence per cubic yard, of breaking the wash by means of the small shovel, and elevating by means of the gravel pump, and hauling the wash to the sump over an average distance of 800 ft., was as follows: Breaking ground, loading, and trucking, 6.80; operating crew on gravel pump, 1.32; sluicing in sluice boxes, 1.90; lubricating oil, 0.86; coal, 5.72; stores and repairs, 1.50; white supervision, 5.14; management and rents, 1.48; power for lighting, 0.51; total, 25.23 pence. This cost includes all charges in connection with draining the cut when the pump was not employed pumping gravel.

All units, including the shovels, were steam operated, as electric power has only recently become available by the development and completion of the Kurra Falls hydro-electric plant, power being now supplied throughout the field by the Nigerian Electricity Supply Corporation. Coal for steam plants was obtainable from government collieries in southern Nigeria at a cost of £3 per ton, delivered on the machine—a heavy item in operating costs, especially on a high-powered unit such as a 300-ton shovel, whose three engines together developed about 300 hp. The machine stripped 196 cu.yd. per ton of coal consumed, and averaged 2,500 cu.yd. per day. This was not full capacity. Stripping costs averaged 6.4 pence per cubic yard, made up as follows: Fuel, 2.49; white wages, 1.19; crew wages, 0.75; oil and stores, 1.15; repairs, spare parts, 0.44; overhead charges, 0.38. One set of dipper teeth, digging hard basaltic clay and gravel, averaged 236,625 cu.yd. One main hoist rope, 2 in. diameter, averaged 147,863 cu.yd. Digging time averaged 72.1 per cent. Average total costs, in pence per cubic yard, in mining as described in this example, averaged as follows: Native wages, 4.50; stores, 2.39; coal, 4.81; white salaries, 3.58.

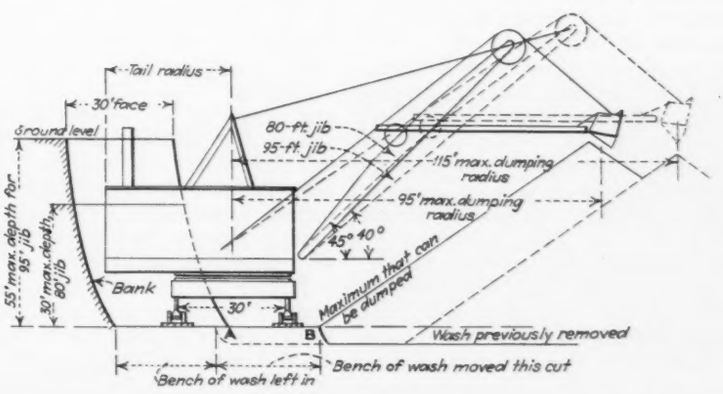


Fig. 3—Transverse section through cut, showing bank and dump

Diamond-Drill Sampling Practice

W. Rex Storms

THE principal reason for diamond drilling when prospecting for ore is to obtain accurate samples of the material drilled, necessitating (1) care by the drill crew, to obtain full core and sludge; (2) accurate sampling by the sampler or geologist in charge, to insure a representative sample.

The main objective of drilling, as seen by the drill crew, is to obtain footage, by increasing which they will usually lower the cost per foot of ground drilled. But by trying to increase the footage they will decrease core recovery, lessen the accuracy of sludge recovery, and possibly deflect direction of the hole by putting extra pressure upon the drilling bit. To prevent such practices is one of the main problems for the engineer in charge of diamond-drill operations. Unless the drill crew is made to realize at the first opportunity that the primary object is to obtain accurate samples, and not footage alone, the resulting samples will be unrepresentative. If the drill crew does good work in an effort to obtain an accurate sample, but if the sampler does not take his samples in the proper manner, the final result will be in error. Close cooperation between drill crew and sampler is essential.

To obtain accurate samples, the driller should use a 5-ft. core barrel if the samples are to be taken every 2½ or 5 ft. Or, he should use an 8- or a 10-ft. barrel if the samples are to be taken every 3 or 4 ft. When a 10-ft. barrel is used and 3-ft. samples are taken, not more than 6 ft. should be drilled at one time. Not more than 5 ft. should be drilled if a 10-ft. barrel is used instead of a 5-ft. barrel for taking 2½- or 5-ft. samples. The reason for this is that when 10 ft. is drilled at one time, especially in a soft formation, and in holes drilled at an angle, the weight of the long length of core in the barrel will tend to crush the softer parts of the core, even though good core was obtained when it was first drilled. In a short-core barrel, when only a few feet is drilled at a time, the core recovery will be higher and the core can be more accurately divided into sample lengths.

The driller should also watch his bits and use as sharp a bit as is economically possible. A dull bit tends to grind and crush the core more than does a sharp one, because more force has to be applied to make it drill. This forcing may also deflect the hole from its original course.

Aside from the precautions mentioned in the foregoing, which apply mainly to the core, other practices should be followed. The driller should stop his machine after drilling the distance of the required sample, but he should let the water continue to run down through the drill rods to the bottom of the hole and out again around the rods until this water comes out clear. By following this practice, the driller makes sure that all sludge from the sample has been washed from the hole.

The precautions mentioned cause delays; but, as already stated, the primary reason for drilling is to obtain accurate samples. Of course, the point should not be over-stressed if extreme sample accuracy is obtainable only by increasing the drilling cost out of all proportion to the results obtained.

To ascertain if the sampler is taking an accurate sample, a study must be made of the relation of core drilled to sludge obtained. The volume of core is equal to the area of a cross-section of the core multiplied by its length.

_____ Level_____ Block, Hole No. _____ Page_____ Co-ordinates-Start _____

Bearing_____ Angle_____ Elev. of Collar_____ End _____

Feet Drilled	Feet Core	% Core	Core Sample			Sludge Sample			Av. Assay	From	To	Geological Record
			Feet	Wt.	Assay	Feet	Wt.	Assay				

Form of drill log

Similarly, the volume of the sludge is equal to the total cross-section of the hole multiplied by its length, minus the volume of the core. If the average specific gravity of the rock drilled can be assumed to be the same throughout, weights of core and sludge are directly proportional to their volumes.

By thus comparing weights of core and sludge to the volume of core and sludge, the sampler can determine by calculation if he is obtaining 100 per cent sludge recovery. This check is merely approximate, as most of the heavier material may be in the sludge or it may be in the core.

Failure of the sampler to make a good sludge recovery is because part of the sludge is escaping in fissures in the drill hole, or because of loss on the surface. If a measured amount of water is pumped down the drill hole and a quantity is returned within 5 per cent of the original amount, all sludge is apparently being washed out of the hole, if drill water is allowed to run after the required length of sample has been drilled. In this case the loss must be in the collection of the sludge. Addition of more settling space, and a more careful recovery of the sludge from this space, will remove the latter cause of loss.

In the treatment of the final results obtained from the samples of a diamond-drill hole, the core and sludge samples usually must be treated as related units when calculating the average metal content of the deposit. H. T. Matson and G. A. Wallis, in their paper on "Drill Sampling and Interpretation of Sampling Results in the Copper Fields of Northern Rhodesia" (A.I.M.E., Tech. Pub. 373, 1930), say that if core and sludge recovery is 100 per cent, the two samples can be treated separately, as in the case of two channel samples cut side by side. But this rarely occurs in drilling mineral deposits, especially if the ore minerals are softer than the gangue, or vice versa. This is especially true when drilling galena or sphalerite distributed irregularly through a harder gangue. The softer minerals will always be pulverized more than will the harder ones, and will be contained in the sludge to a higher degree than in the core. For this reason the volumes of core and sludge should be accurately calculated for each sample. An average assay for the sample, containing the correct proportions of core and sludge assays, can then be calculated.

In sampling the core from a diamond-drill hole the usual custom is to take samples every 3 or 5 ft. If the deposit is very irregular, with spots of high-grade ore mixed with spots of lean material, samples may be taken every 2½ ft. Samples are sometimes split at contacts between two rocks or at contacts between waste and ore. When this is done the resulting assay may not be correct, because the sludge sample has been taken for the full dis-

Fig. 1 — Typical diamond - drill shop, with core rack and setter's bench. Core is left in rack until examined and sampled by geologists; then specimens are taken and filed in another rack.

tance of the sample of 3 or 5 ft., or whatever sample length was used. If a core recovery of 100 per cent resulted, the sample can be split and the sludge sample neglected; but to separate core samples into lengths that do not correspond to the sludges is poor technique.

In drilling the hole the operator keeps an accurate record of its depth at any given time, by measuring the bit and core barrel and counting the number of rods used. Thus he can determine when he has drilled the required footage for the sample. Then, he pulls or removes the rods from the drill hole and carefully places the core in the box made to receive it. In many instances this core is placed in a tray, each row being separated by narrow strips, and the tray is placed in a core box, which is locked. In Fig. 1 several empty trays can be seen beneath the large core rack, and some full trays in the rack. These trays are carried in the boxes stacked at the right end of the core rack.

In the office, or where the sampler works, the core is carefully measured and weighed. It is then examined by the geologist or sampler, and complete data are recorded. The core may be laid out for examination on strips of ordinary corrugated iron roofing, especially if wooden racks are not available. A type of drill log is shown on page 58; other details may be added to suit individual cases. Some exploration companies require a carefully written description of each sample; others merely require a continuous log, describing contacts and other items of information as disclosed from day to day. The former method is the better; a complete description of each sample and its assay value results.

After the cores have been measured, weighed, and described, they are carefully split lengthwise into two halves. One half is sacked and sent for assay, and the other half is kept "on file." If a check assay is desired, the second half is thus available. Although several of the well-known diamond-drill companies sell core splitters, I have sometimes had to split core by using an ordinary blacksmith's dolly, a cold chisel, and a single jack. This, however, is recommended only for emergencies.

The taking of diamond-drill sludge samples is a difficult and important part of the work. Where 100 per cent core recovery results, the sludge-sample assays do not play an important part. In fact, under those conditions they may be omitted altogether. But where the material drilled yields unsatisfactory cores, the resulting sludge plays an important part in calculating the average content of the sample.

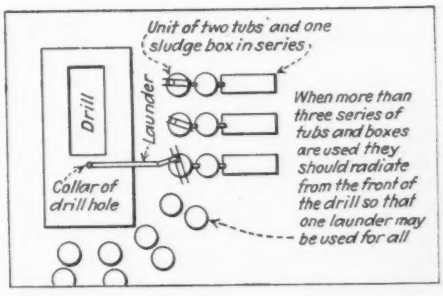

Unit of two tubs and one sludge box in series
Drill
Launder
Collar of drill hole
When more than three series of tubs and boxes are used they should radiate from the front of the drill so that one launder may be used for all

Fig. 2—Sludge equipment arrangement

As already stated, sludge samples are taken to correspond to the core sample. The operator drills the required depth for the sample, carefully measuring the footage on the rods, then stops the drill and turns on the water with considerable force. The water washes all sludge out of the hole, the slime first, then the fine material, and finally the coarse particles. He watches this water as it leaves the top of the drill hole, and does not start to drill again until it has run clear for several minutes. After the driller is reasonably sure that all the sludge has been washed out of the hole, he again drills the required number of feet for the next sample, and then repeats the operation.

To carry away the sludge from the drill, a tee is usually put on top of the casing at the collar of the drill hole; a short piece of casing, usually a piece of standpipe, is cemented to the collar of the hole, and the hole is drilled through it. A piece of pipe or a launder is attached to this tee, as shown in Fig. 2.

The pipe or launder from the top of the drill hole leads to some form of settling device. Figs. 3 and 4 show settling equipment I used in South America. One or two half barrels comprised the first container. Sludges flowed into these through 5-gal. gasoline cans with the tops cut out, punched full of holes, and nailed to two 1-in. square strips. These reduced the velocity of the sludge water and collected a large part of the coarse particles. The water flowed out of the cans into the barrels. A single baffle plate was sometimes hung down in the tub to hinder the current. During the early part of this drilling, two half tubs, or barrels, were used when small sludge boxes were used. Fig. 3 shows only one tub. As shown in Figs. 3 and 4, the sludge went from the half barrel into a large hindered-settling box, Fig. 3. This contained seven baffle boards, three of which extended up from the bottom of the box, and four hung from the top nearly to the bottom. All were made removable, so that the box could easily be cleaned. By the time the last baffle plate is reached all sludge has settled to the bottom of the box and only clear water is discharged at the lower end.

Three groups of settling equipment were used, as shown in Fig. 3. Many such groups may be necessary if the sludge settles very slowly. The sludge was run into one tub and box until the required footage for the sample was

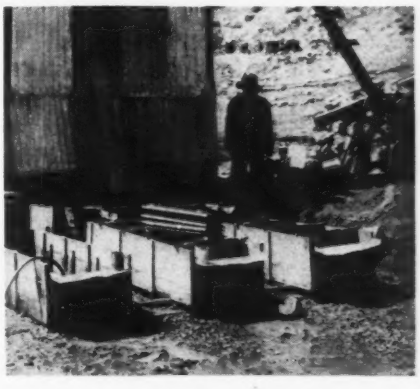


Fig. 3—Sludge equipment showing one tub and one sludge box. Tub and box on left are being cleaned; series in center is being filled with sludge; tub and box on right are clean and ready to receive sludge.

Fig. 4—Sludge equipment showing two tubs and box. Larger boxes were substituted

Fig. 5—Sludge-sample drying stove

drilled—3 ft. in this case. Then the launder was turned into the next tub, and so on. By the time the third tub had been reached, the particles in the first tub and box have settled to the bottom. The clear water in this tub and box is then decanted off by using a small rubber hose as a siphon (see Fig. 3). The can, tub, and box are now carefully cleaned of mud and remaining water, and both are placed in an empty 5-gal. gasoline can. Each can is numbered, and a record kept corresponding to this number to show footage of sample. The first tub and box is now washed out, and ready to be used again. This procedure is continued until the drill hole is finished.

Water in each of the numbered sample cans is decanted off as it clears, until only mud is left. This can, with the wet mud, is next taken to the stove shown in Fig. 5, and thoroughly dried. After the sludge samples are dried they are weighed, and the weights recorded with the corresponding core sample. The sample is thoroughly mixed on a large piece of oilcloth, then quartered several times, and a 4-lb. sample taken for assay. A Jones split can be used for dividing the sample.

As mentioned before, when recovery of core and sludge is not 100 per cent these must be treated as related units when calculating the average metal content of the sample. R. D. Longyear, in his paper on "Diamond-drill Sampling Methods" (*Trans.* A.I.M.E., Vol. 68, pp. 423-430, 1923), says, "To obtain the average analysis of the material drilled in a given run, the separate analyses of both core and sludge must be combined in the proportion of their respective masses."

As already mentioned, the volume of the core is to the volume of the sludge as the weight of the core is to the weight of the sludge. This would not be true, however, if the hole had been drilled through a heavy mineral such as galena, in a light-weight but hard gangue. In that case the sludge would have contained a larger part of the heavier galena than was contained in the core. Therefore those volumes would not have compared directly to their weights. However, volumes are usually assumed to be proportional to their masses. Approximate diameter of the diamond bit is always known for each sample drilled. Volume of hole can then be calculated for length of sample. Volume of the core can also be calculated by actual measurement. Then, by deducting volume of core from total volume of hole for a certain sample, volume of sludge is known. Taking the total volume of hole as 100 per cent, the volumes of core and sludge can be calculated as percentages. By multiplying the respective assay of each by its percentage volume, adding them together and dividing the sum by 100, or the volume of the core plus sludge, an average assay for the sample is found. Or, assuming that volumes are proportional to weights, average assay can be found by the same method. This latter average should nearly equal the average value as calculated from volumes; it can be used as a check on the first calculation. If widely different figures are obtained, this fact will show that the specific gravities of sludge and

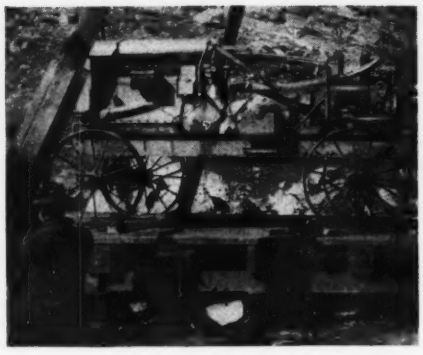


Fig. 6—Drill with hydraulic removed. Drill should be set high off ground, to facilitate taking sludge samples

core were not the same, as assumed. This calculation of average value is near enough to the true value for practical purposes.

Some authorities recommend the use of full-sized barrels, several in series, as sludge-settling tanks, but I have tried this method and found that tall barrels are difficult to clean out when they are filled with sludge.

■ ■ ■

Current Collectors for Mine Haulage

BECAUSE of conditions under which it operates, the current collector for mine electric locomotives has few parts in common with the other types of pole collectors, according to G. W. Bower, of the General Electric Company's Transportation Engineering Department. It is designed to operate under restricted head and side room, and at the same time to give the operator maximum protection, as when aiding the pole head to maintain contact on displaced sections of overhead and through special constructions. For this reason the base portion is insulated from the pole head by using a wooden pole. Electrical connections between pole head and locomotive wiring are made by insulated cable.

Two types of bases are used for mining service—a vertical type where it is occasionally necessary to lift it out of the socket for reversed locomotive operation, and a flat type which may be turned in the usual way. If the mine collector is required to work under restricted headroom, and the flat type of base is used, the highest portions of the base are insulated, so as to obviate a short between base and contact wire where it sags between supports. Almost all mining collector bases are equipped with locking devices for holding the pole socket in a horizontal position while the pole and pole heads are changed, or when the collector is not in service.

Operating voltage for mine locomotives as a rule is about one-half of that of street railways, and hence the current to be collected per horsepower is always greater. The tendency is toward larger locomotives, and the current demands are continually increasing, so that from 1,000 to 1,500 amp. or more per collector is not unusual. These currents are far beyond the economical collecting capacity of a wheel, so heavy-duty slider shoes have entered the field.

Because of the various positions of the overhead trolley wire with respect to the collector, and also because of the large horizontal angles of the overhead contact system, the swivel-type spring-center biased pole head is universally used. This type of pole head allows either the wheel or the shoe to remain in the same vertical plane as the trolley wire for the normal amount of displacement of the overhead system with respect to the track.

For mining service, the speed of operation is low, and refinements are not essential. The weight of the wheel may be somewhat heavier than for street-railway work. The harp should be strong in construction, and it should also have a free working swivel, so that it can readily adjust itself to the irregularities in the overhead system.

Where more than 500 amp. are to be collected continuously the heavy-duty swivel slider shoe type of pole head will be found best, although care must be exercised while backing.

Metallurgical Practice at Broken Hill, New South Wales

Milling practice along the Broken Hill lead-zinc-silver lode, in New South Wales, Australia, has undergone many changes in recent years. Metallurgists of the district have made noteworthy contributions to ore-dressing technique, particularly in the field of flotation. The committee of the Broken Hill branch of the Australasian Institute of Mining & Metallurgy recently issued, for the information of members attending a meeting at Broken Hill, a bulletin that has been used in the preparation of the article that follows.

■

TWO methods of ore treatment are employed at Broken Hill, Australia. At the mill of the North Broken Hill company, the finely ground ore is treated by selective flotation alone, whereas at the Central mill of the Sulphide Corporation, the mill of Broken Hill South, and that of the Zinc Corporation, fine grinding and flotation are preceded by coarse crushing in rolls and gravity treatment with jigs and tables.

Practice at the North mill consists, briefly, of fine crushing crude ore to about 5 per cent plus 40 mesh I.M.M. screen; then classifying the crushed ore into "granular" ore and "fines" ore. Each of these fractions is treated separately in flotation machines for recovery of both lead and zinc concentrates. The lead concentrate is obtained first, using an alkaline circuit of soda ash and the following flotation reagents: potassium xanthate, sodium silicate, eucalyptus oil, and coal tar. Tailing from the deleading operations is subsequently dewatered, and the zinc concentrate is then obtained in an acid circuit of sulphuric acid, using bluestone and eucalyptus oil as flotation reagents. The unrecovered part of the ore constitutes a final residue, which is used for mine filling. Concentrate re-treatment, with fractionating of concentrate overflows, is practiced, the object being high-grade concentrates.

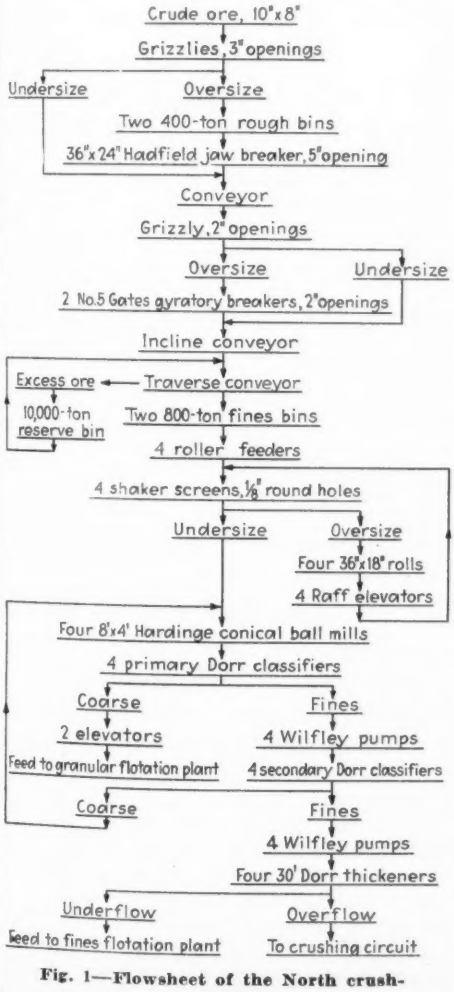


Fig. 1—Flowsheet of the North crushing plant

Crude ore, 10x8 in., is stage crushed, as shown in Fig. 1, passing first to a 36x24-in. Hadfield jaw breaker. The 5-in. product of the breaker is reduced to 2 in. in two No. 5 Gates gyratory crushers, and then to $\frac{1}{8}$ in. by four sets of 36x18-in. rolls. On leaving the rolls, the ore goes to four 8x4-ft. Hardinge conical mills, where it is reduced to 5 per cent plus 40 mesh. Equipment in the crushing plant also includes coarse grizzlies, and four Weir-Meredith screens, fitted with $\frac{1}{8}$-in. round-hole punched plate, which operate in closed circuit with the rolls.

The crushed ore passes to four Hardinge ball mills, and thence to four primary Dorr classifiers, the coarse discharge of which constitutes the feed to the granular flotation plant. Fines from the primary classifiers go to four secondary classifiers, the coarse product returning to the ball mills and the fines going to four Dorr thickeners. Underflow from the thickeners constitutes the feed to the fines flotation plant. The various steps in the flotation operations are shown in Figs. 2 and 3.

Quantities of reagents used per ton of crude ore for the four weeks ended May 21, 1932, were (1) zinc flotation: sulphuric acid, monohydrate, 6.58 lb.; bluestone, 0.49 lb.; eucalyptus oil, 0.25 lb.; (2) lead flotation: eucalyptus oil, 0.06 lb.; coal tar, 0.06 lb.; potassium xanthate, 0.05 lb.; sodium silicate, 0.15 lb.; soda ash, 0.79 lb.

Capacity of the North milling plant is 10,000 tons of crude ore per week of 132 hours. The Hadfield breaker and the two Gates crushers, working conjointly, have a capacity that exceeds 100 tons per hour, crushing from 10 to 2 in. A 135-hp. motor drives the breaker, and the power required under full-load conditions averages 75 hp. The crushers are each driven by a 35-hp.

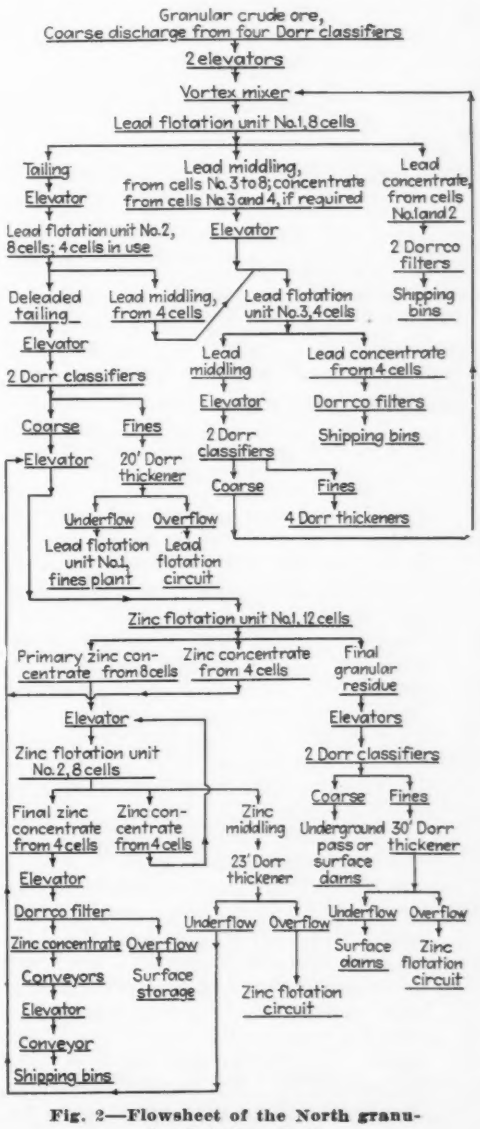


Fig. 2—Flowsheet of the North granular flotation plant

motor, and the power required for each crusher under full-load conditions averages 18 hp.

The rolls section, consisting of four sets of rolls, four screens, and four Raff elevators, is operated by a 550-hp. motor, and the power required under full-load conditions averages 230-hp.

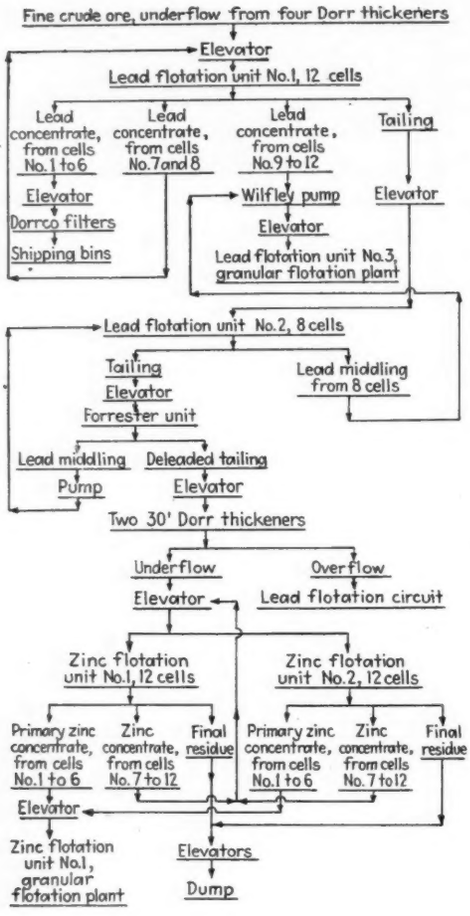


Fig. 3—Flowsheet of the North fines flotation plant

Each set of rolls requires about 50 hp. Capacity of the section is 80 tons of crude ore per hour, with a reduction from 2 to $\frac{1}{8}$ in. An 18-ton charge of 2-in. diameter cast-steel balls is used in each of the four Hardinge mills. Indicated ball consumption is 1.6 lb. per ton of ore. Each mill is driven by an individual 126-hp. motor through a "V" rope drive. Average power consumption per mill is about 87 hp. The crushing reduction is from $\frac{1}{8}$ in. to 5 per cent plus 40 mesh I.M.M. screen.

The flotation units were designed at the North mill, and are modifications of the Minerals Separation machine. Nine groups of machines, comprising 80 cells, are in use: 16 cells on granular lead, 20 on fines lead, 20 on granular zinc, and 24 on slime zinc. Impellers, within the cells, are attached to hollow spindles, which are driven through belting at 560 r.p.m. Power consumption is 6 to 7 hp. per spindle. The impellers are 15 in. diameter, and have a shroud of 12 in. diameter at the top. Each impeller has four blades, 3 in. in vertical height and set to upthrow at an angle of 45 deg. At the aforesaid speed, the impellers, with their shrouds, act as pumps, creating a vacuum. This results in atmospheric air and air under pressure being drawn down the hollow spindle to the bottom of the cell, where the air is incorporated with the pulp, thereby causing the chemically prepared sulphide particles to float to the surface of the cell as a concentrate product. The major part of the primary concentrate thus obtained is re-treated by flotation. It is then dewatered in Dorrco filters, and shipped as high-grade concentrate.

Lead concentrate at the North mill has recently averaged 74.1 per cent lead, 44.7 oz. per ton of silver, and 4.5 per cent zinc. Zinc concentrate has averaged 2.6 per cent lead, 1.8 oz. silver per ton, and 52.5 per cent zinc. Lead recovery in lead concentrate averaged 94.9 per cent; recovery of silver, 89.5 per cent; recovery of zinc in zinc concentrate, 86.1 per cent.

The major part of the granular residues are dewatered in Dorr classifiers, the coarse discharge of which is delivered by conveyor to an underground sand pass for filling purposes. The remainder of the granular residues and all the slime residues are elevated and run into surface dams.

At the Central mill, the trucks of ore, on arrival at the surface, are weighed on a self-indicating weighbridge and tipped by revolving tumblers into a 750-ton bin. Thence, as shown in Fig. 4, the rough ore is crushed by two Hadfield's Helcon, size S, gyratory crushers. The broken ore then passes through 4x8-ft. trommels, with $2\frac{1}{4}$-in. holes, the oversize being reduced to $1\frac{1}{2}$ in. in two Jacques 20x12-in. roll jaw crushers. A cable tramway, with a capacity of 100 tons per hour, transports the crushed ore to the mill bins.

The general arrangement of the treatment plant is as follows:

1. Crusher section. Equipment includes 6x4-ft. Jacques screens, 30x15-in. rolls, four-hutch May jigs, 5x10-ft. tube mills, and 8-ft. grinding pans. The jigs produce a final lead concentrate for shipment.

2. Cascade section. The jig tailing is reground in the tube mills and treated with soda ash, cresylic acid, and potassium xanthate. A lead concentrate is produced, and the residues pass to the zinc section.

3. Slime section. All of the slime produced by crushing operations flows to Dorr thickeners, and thence to selective mixers, where reagents, similar to those used in the cascade section, are added. The lead concentrate produced joins that from the cascade section, and both are dewatered by a six-leaf American continuous filter, which discharges direct to railway trucks. Residues go to the zinc section.

4. Zinc section. Residues from the cascades and selective mixers unite to form the feed to the zinc section, where, with the addition of sulphuric acid, copper sulphate, xanthate, and eucalyptus oil, a leady-zinc concentrate is produced by the Minerals Separation flotation process. This concentrate goes to the deleading and reflotation section, and the residues go to the dams for drainage.

5. Deleading and reflotation section. Wilfley tables and horizontal flotation mixers treat the mixed concentrate from the zinc section. Final lead and zinc concentrates are produced.

Weekly production at the Central mill ranges from 450 to 500 tons of lead concentrate and 650 to 700 tons of zinc concentrate. Bulk lead concentrate has recently averaged 73.8 per cent lead, 58 oz. silver per ton, and 5.1 per cent zinc. Bulk zinc concentrate averaged 2.1 per cent lead, 4.6 oz. silver per ton, and 53 per cent zinc. Lead recovery in lead concentrate averaged 93.9 per cent; silver recovery in lead concentrate, 82.8 per cent; and zinc recovery in zinc concentrate, 89.1 per cent. The comparatively low recovery of silver in the lead concentrate and the high silver content of the residues are probably mainly attributable to oxidation of cer-

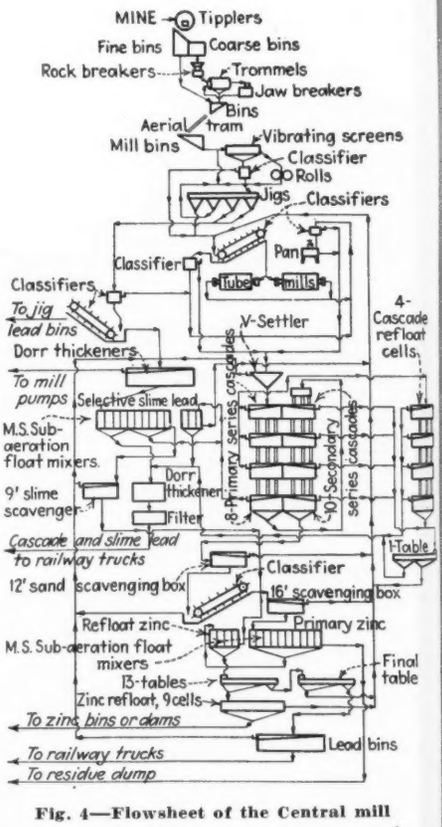


Fig. 4—Flowsheet of the Central mill

tain silver-bearing minerals in the ore. The oxidized lead content of the average crude ore treated is unusually high.

An important adjunct to the Central mill is the sulphuric acid plant, consisting of two Schroeder contact units, with a capacity of 10 tons of monohydrate acid per day.

At the South mine the ore is hoisted

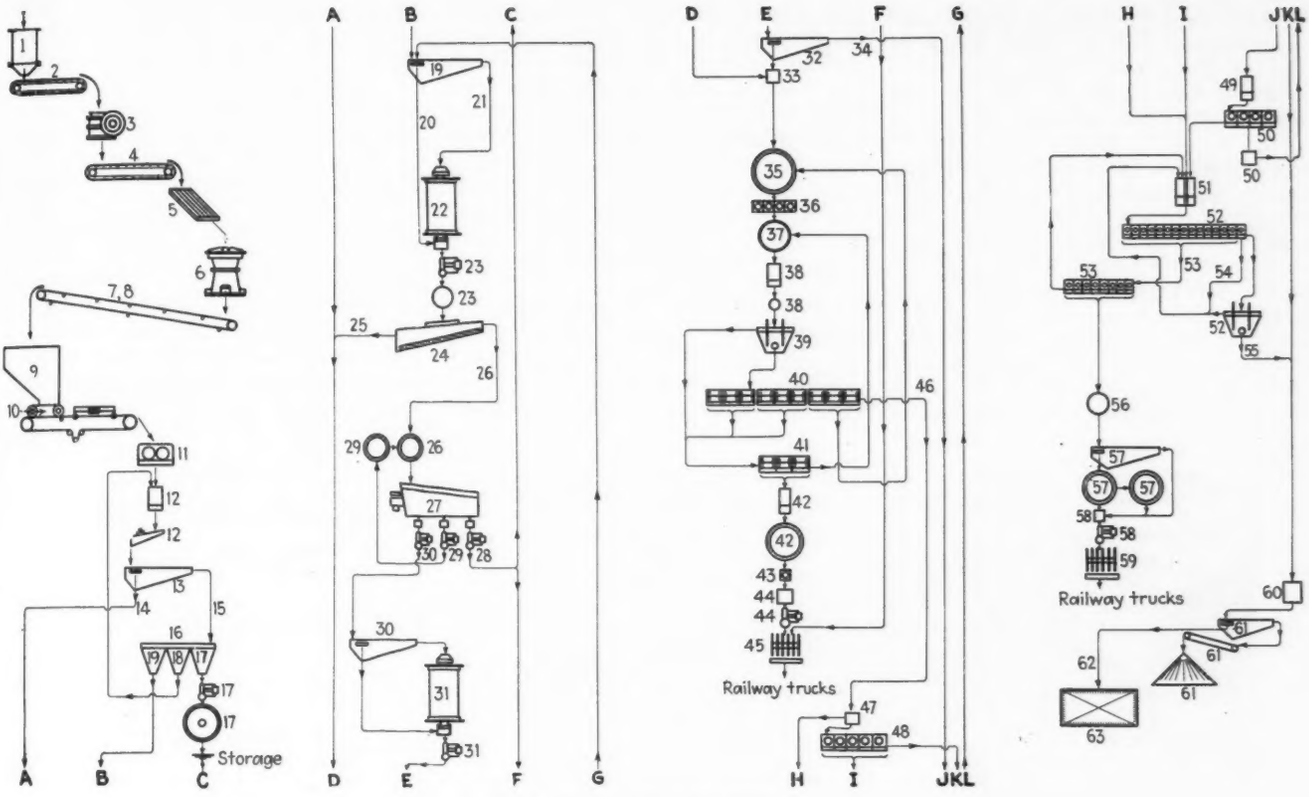


Fig. 5—Flowsheet of the South mill

1. Crude ore bin, 100 tons' rilling capacity.

2. Apron feeder, 3 ft. 6 in.

3. Jaw crusher, 36 in. x 24 in., Hadfield type, 6-in. discharge opening.

4. Apron feeder, 3 ft.

5. Cataract grizzly, 42 in. wide, nine 12-in. rollers, 20 deg. slope, 2¼-in. opening over which is placed a magnet.

6. No. 52 Telsmith secondary gyratory crusher, 2-in. opening.

7, 8. Belt conveyors, 30 in., with 18-in. Dings bipolar magnet and Blake-Denison weightometer.

9. Three crushed ore bins and stockpile, 3,000 tons.

10. Four apron feeders with 20-in. conveyor belts, No. 3 fitted with a Blake Denison weightometer.

11. Four pairs 36 in. x 18 in. rolls; one plain, one flanged, in close contact. Gear driven at 16 r.p.m., water added.

12. Four jig elevators, elevating to four No. 39 Hum-mer screens, 4 ft. x 5 ft. x 4.22 mm. Undersize gravitates to jig classifier, oversize gravitates to rolls.

13. Four jig classifiers, drag type; water basin, 16.5 sq.ft. each; rake speed 38.5 ft. per min.

14. Four jig classifier overflows flow to 4-in. centrifugal pumps delivering to four 25-ft. Dorr thickeners.

15. Four jig classifier discharges constitute feed to May Bros. duplex jigs.

16. Four May Bros. duplex jigs, 184 strokes per minute.

17. Lead concentrate gravitates to a 2-in. centrifugal pump and is pumped to 3-in. centrifugal pump which delivers to storage.

18. Four jig middling gravitates to the jig elevator.

19. Jig tailing gravitates to tube mill dewatering classifiers; water basin 18.5 sq.ft. each, rake speed 60.6 ft. per min.

20. Four tube mill drag classifiers, overflows join the tube-mill discharge.

21. Four tube mill classifiers discharge to four 10-ft. x 5-ft. tube mills.

22. Four 10-ft. x 5-ft. tube mills operating at 26 r.p.m. Grinding media, 2-in. hard white-iron balls.

23. Four 3-in. centrifugal pumps, and No. 1 distributor.

24. Four Model C20 18-ft. x 54-in. Dorr duplex classifiers, 2¾-in. slope; water basin each 36 sq.ft.

25. Four Dorr classifier overflows flow to four 25-ft. Dorr thickeners at the slime lead plant.

26. Table classifier distributor. Four rows of seven Butchart tables.

27. Twenty-eight Butchart modified linoleum top tables, 203 strokes per min., ⅝ in. or ¾ in. stroke.

28. Table lead concentrate gravitates to a 2-in. centrifugal pump and is transferred to 3-in. centrifugal pump that discharges to storage.

29. Table middling gravitates to two 2½-in. centrifugal pumps and returns to tables.

30. Table tailing gravitates to two 3-in. centrifugal pumps and is delivered to one of two drag classifiers.

31. Two 10-ft. x 5-ft. regrind tube mills and 4-in. centrifugal pumps, operating delivery to four dewatering classifiers.

32. Four dewatering classifiers; water basin, 20.25 sq.ft. each; rake speed, 35.3 ft. per min.

33. Four dewatering drag classifier overflows, transferred to four 25-ft. Dorr thickeners.

34. Four dewatering drag classifiers; discharge constitutes feed to scavenging flotation machine, four cell SM. type.

35. Four 25-ft. Dorr thickeners.

36. Quadruplex diaphragm pump.

37. 20-ft. diameter agitator; speed, 8½ r.p.m.

38. Elevator feeding sampling machine and Forrester cell; 44-ft. center, 14-in. x eight-ply belt; speed, 285 ft. per min.

39. Forrester cell, 35 ft.

40. Two rows of three machines, or 18 cells; Seale & Shellshear flotation machines. Lead concentrate from first and second machines, or from twelve cells, flows to the concentrate from the 35-ft. Forrester for reflotation. Froth from No. 3 machine of each row, or six cells, returns to Dorr thickener.

41. One three-cell cleaner, Seale & Shellshear flotation machine.

42. Lead concentrate elevator; 43-ft. center, 14-in. x eight-ply belt; delivering to 20-ft. lead thickener; belt speed, 243 ft. per min.

43. Simplex diaphragm pump.

44. One 2-in. centrifugal pump delivering lead concentrate to 6-ft. American filter.

45. One 6-ft. American filter, 200 sq.ft.

46. Deleaded residues returned to 3 ft. square box.

47. Square box, 3 ft., for dividing slime.

48. Five-cell Hebbard rougher machine treating portion of the slime. Rougher zinc concentrate flows to main feed elevator. Residues to disposal system.

49. Four-cell scavenger machine elevator.

50. Four-cell South mine flotation machine. Lead middling returned to No. 19; tailing sent to No. 51.

51. Two main feed elevators, feeding fifteen-cell Hebbard machines.

52. Fifteen-cell Hebbard rougher flotation machine and 18-in. Forrester machine.

53. Nos. 1 to 14 cells return to the eight Hebbard cell cleaners.

54. No. 15 cell and the Forrester cell concentrates returned to the main feed elevator.

55. Residues from Forrester cell flow to disposal system.

56. Cleaner zinc concentrate flows to 12-ft. tank and is pumped to thickening plant.

57. One duplex drag classifier overflow flows to two 25-ft. Dorr thickeners, in series.

58. Concentrate from No. 57 added to thickener discharge of No. 57 and then flows to a centrifugal feed pump.

59. Six-leaf 6-ft. American filter.

60. Residue pump delivering to five drag classifiers.

61. Five drag classifiers and 36-in. drainage belt discharging to sand storage.

62. Five drag classifier overflows flow to slime dam; water is sent to mill storage.

63. Water dam.

in 5-ton skips, the contents of which are automatically dumped by a tippler at the top of the new No. 7 shaft into a crud-ore bin, shown in Fig. 5. An apron feeder delivers the ore to a 36x24-in. jaw crusher, operating in series with an apron feeder, a cataract grizzly, and a No. 52 Telsmith gyratory crusher. Product of the crusher falls onto a 30-in. conveyor that delivers to the stockpile adjacent to the rolls bin at the mill. Ore is drawn from the stockpile, and delivered to the roll bins by 20-in. belt conveyors. Apron feeders move the ore from the roll bins to the rolls, which are 36x18-in., rotate at 16 r.p.m., and operate in closed circuit with No. 39 Hum-mer screens. The oversize returns to the rolls, and the undersize goes to the jig classifiers.

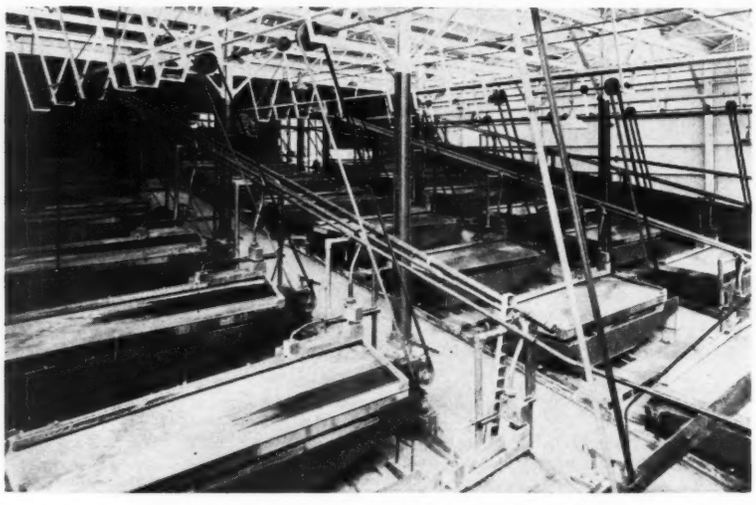


Table department in the lead section of the South mill

Sand from the jig classifiers passes to duplex three-hutch May jigs, which produce (1) lead concentrate, stored in vats for shipment to Port Pirie; (2) lead middling, returned to the jig elevator; and (3) jig tailing, sent to the tube-mill classifiers for dewatering. Sand from the tube-mill classifiers is ground to 10 per cent plus 40 mesh I.M.M., which product, with the overflow of the classifiers, is pumped to distributors that discharge to four Dorr classifiers. The sand from each Dorr classifier provides the feed for seven Butchart tables, which produce (1) lead concentrate, stored in vats for shipment; (2) lead middling, returned to the tables; and (3) tailing, pumped to the secondary tube mill classifier. Sand from this classifier is discharged to the secondary tube mill, where it is ground to 7½ per cent plus 40 mesh I.M.M. This product, with the classifier overflow, is pumped to the dewatering classifiers at the zinc section.

Sand from the dewatering classifiers is treated with eucalyptus oil and ethyl xanthate, and scavenged in a South Mine flotation unit that produces (1) a middling, sent to the tube mill classifiers, and (2) a tailing, added to the zinc plant feed. Slime overflows from the jig classifiers, Dorr classifiers, and dewatering drag classifiers discharge into a pump sump, and thence to four Dorr thickeners. Diaphragm pumps move the pulp, 50 to 55 per cent solids, from the thickeners to an agitator, where it is conditioned with soda ash before passing to the selective lead flotation machines. Ethyl xanthate, eucalyptus oil, and sodium silicate are added in the boot of the feed elevator.

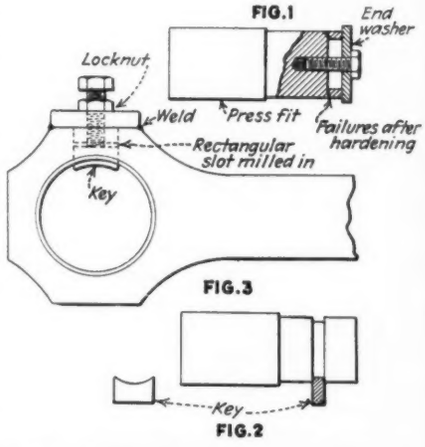
Lead concentrate is thickened and pumped to a 6-ft. American filter, where it is dewatered to 7½ per cent moisture, and then loaded into railway trucks for shipment. The deleaded residues are pumped to the zinc section, and join the tailing from the aforesaid four-cell scavenging flotation machine. Copper sulphate, soda ash, eucalyptus oil, and sodium Aerofloat are added to this pulp. It is then treated for zinc in 28 Hebbard flotation cells and an 18-ft. Forrester cell. Twenty of the Hebbard cells and the one Forrester cell are roughers; the remaining eight Hebbard cells are cleaners. Residue from the cleaning cells is returned to the feed. The zinc concentrate is sent to a drag classifier, where the granular zinc is removed, the overflow going to two 25-ft. Dorr thickeners arranged in series. Overflow from the second thickener returns to the water storage. Thickened zinc concentrate, with the granular zinc, is pumped to a 6-ft. American filter, where it is dewatered and discharged into railway trucks for shipment to Port Pirie.

Zinc plant residues, 60 per cent of which are used for mine filling, flow to the first of three Wilfley pumps arranged in series. These pumps move the residues to a classifier and drainage belt system situated near the main mullock pass. At this point the sand is piled for air drying and delivery to the pass. Overflow of the classifier goes to a dam, whence it is returned to the mill storage dams.

Lead concentrate production for a recent week was 1,192 tons, averaging 74.9 per cent lead, 32.4 oz. silver per ton, and 4.2 per cent zinc. Zinc concentrate production was 1,247 tons, averaging 1.4 per cent lead, 1.5 oz. silver per ton, and 52.7 per cent zinc. Lead recovery in lead concentrate averaged 95.5 per cent; silver recovery in lead concentrate, 89.9 per cent; zinc recovery in zinc concentrate, 84.9 per cent. Final treatment products of the crude ore, in per cent by weight, were as follows: jig lead concentrate, 6.57 per cent; table lead concentrate, 5.23 per cent; slime lead concentrate 7.50 per cent; zinc concentrate, 20.80 per cent; final residue, 59.90 per cent.

Connecting-Rod Pin Repair

BREAKING of connecting rod pins on the small compressed air-driven locomotives used for underground haulage was a frequent occurrence at the property of Nevada Consolidated Copper Company, at Ray, Ariz., writes E. J. Harris, assistant master mechanic. The failures usually occurred after case-hardening of the pin at points indicated in Fig. 1 of the accompanying illustration. This difficulty was overcome by using the type of pin shown in Fig. 2, the essential features of which are the absence of a depression at the end of the pin, to accommodate the end washer and bolt, and the application of a small rill and a key to secure the connecting rod to the wheel pin. The only modification required on the connecting rod head was the milling in of a rectangular slot and the welding on of a steel extension, as shown in Fig. 3.



Rock Drills and Accessories—I

Lucien Eaton

IN THE ten years following the successful development of the Leyner drill in 1909, rock drills and rock-drilling practice were revolutionized, and enormous increases in drilling speed were made. The old piston drills were entirely superseded by mounted hammer drills in drifting and stoping and by hand-held drills in sinking. Simultaneously, the jackhammer and auger drills took the place of hand drills, jumpers, and hand augers, and the air-feed stoper was adopted as standard for raising and back stoping. Since then few radical changes have been made in design. Better materials are used, making possible a marked reduction in weight and lowering the cost of upkeep. Steel forgings have largely replaced those of cast iron, and clearances and finish have been improved; but in its essentials the rock drill of today is the same as that of ten years ago.

By continual experiment the most effective hammer size and number of blows per minute have been determined, and little apparently remains to be accomplished in this respect. Later developments in design are more in the way of simplicity, durability, and standardization. One of the more recent improvements is the line oiler, a small reservoir holding one-half or one pint, inserted in the line of air hose near the drill. The oil, fed automatically to the drill by the pulsations of the air, reaches all parts of the machine. This has revolutionized rock-drill lubrication.

Many operators are now placing the greatest emphasis on maintenance costs at the expense of drilling speed. This may be justified in soft ground, where the time required for drilling is short, but repair cost is proportional to drilling speed, and in general it is poor economy, as the total cost per foot of hole really counts.

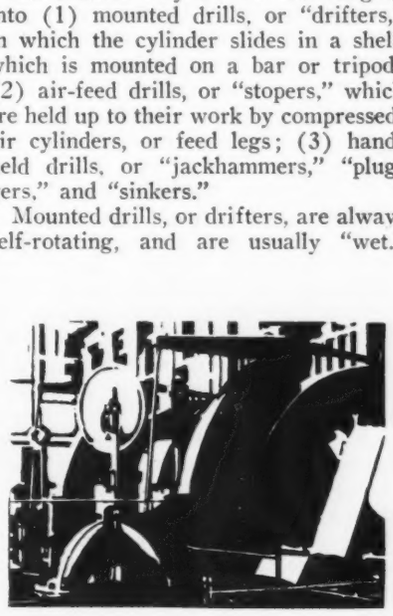
To predict what lines will be followed in making further improvements is difficult. Experimentation has proved that drilling speed is enormously increased by raising the air pressure, the number of feet of free air per foot of hole, however, remaining almost constant. Air pressure of 150 lb. per square inch has been tried, and performance has more than kept pace with the increase in pressure, but this air pressure seems to have passed the economic limit for the materials now available, because neither the drill nor the drill steel will stand up under it, and the increase in drilling speed is more than offset by the delays caused by breakage. Under present conditions the economic air pressure seems to be 110 to 125 lb. per square inch, but a reasonable prediction is that improvements in material will soon make a much higher pressure practicable.

Even under the best conditions a rock drill is seldom hitting the steel more than 40 per cent of the shift, and therefore a logical development would be an increase in this percentage by the avoidance of delays in setting up and changing steel. Hand-held drills for down holes and air-feed drills for uppers have solved the question of set-up, but flat holes are still a problem, and chance for improvement offers in this kind of drilling. By using an air cylinder instead of a feed screw, remarkable increases in drilling speed have been made at Mount Hope, N. J., and at Bonne Terre, Mo. Mounted drills, using this type of feed or having an air motor on the feed screw, are now on the market. A combination of air feed with a quick method of setting up would go far toward solving the problem.

In drifting and tunneling, drill carriages have been fairly successful in reducing the time required for setting up. One of the recent developments has been the use of a heavily loaded car for carrying the drill columns, the weight of the car making the use of jacks unnecessary. On sublevels in medium ground, where small hand-held drills are used for drifting and stoping, the weight of the drill is often carried on a piece of drill steel or plank, by means of which a quick set-up is permitted, and the operator is relieved of much of the fatigue of holding the drill.

Rock drills may be divided roughly into (1) mounted drills, or "drifters," in which the cylinder slides in a shell, which is mounted on a bar or tripod; (2) air-feed drills, or "stopers," which are held up to their work by compressed-air cylinders, or feed legs; (3) hand-held drills, or "jackhammers," "pluggers," and "sinkers."

Mounted drills, or drifters, are always self-rotating, and are usually "wet." Compressed air instead of water is used in a few instances to drive the cuttings away from the bit. The cylinder is normally moved in the shell by a feed screw and crank, but some of the new drills are fed by an air cylinder—an arrangement for which an increase in drilling speed is claimed. Three lengths of feed are furnished, 24 in., 30 in., and 36 in. A few years ago many of the dimensions were standardized, and now almost all drills have cones 5 in. diameter, which will fit on any saddle clamp or tripod. Two types of chuck are in common use. In the "lug chuck" the hammer strikes directly against the end of the drill steel, and the steel is rotated by lugs forged on the shank. The steel and shank are round, and the standard diameter is 1¼ in. In the "anvil-block chuck" a tappet or anvil block is placed between the hammer and the end of the steel, and there are no lugs. The shank and the steel, of the same shape and size, are usually of 1-in. hexagon or ⅞-in. quarter octagon in section. Some maintain that the introduction of the anvil block reduces drilling speed, but the contention is not borne out by tests, which usually show an increase rather than a decrease in efficiency. By the use of the anvil-block chuck, breakage of steel and wear on the drill itself are materially reduced.



The standard type of rotation is a rifle bar, acting in the rear end of the hammer and having at its rear end pawls, which work in a ratchet ring attached to the backhead. Rotation is transmitted to the chuck by means of straight flutes on the front part of the hammer. A few drills have rotations independent of the hammer. In theory this is an ideal arrangement, for it allows the use of a simple, sturdy hammer, less liable to breakage than one with a rifle bar. The independent rotation is useful in rough and broken ground; but in most types the parts are small, and maintenance is high on that account.

The three standard sizes of drifters have cylinder diameters of 3, 3½, and 4 in. The 3-in. machine weighs about 125 lb., and usually uses 1-in. or ⅞-in. hexagon steel. It is strictly a one-man machine, and is used in small drifts and in stoping in medium ground. The 3½-in. machine weighs about 145 lb., and uses 1¼-in. round, 1-in. hexagon, or ⅞-in. quarter-octagon steel, but will handle steel as large as 1¼-in. hexagon satisfactorily. It is generally run by one man, but in some districts a crew of two is standard. This machine, standard for drifts and tunnels in medium and hard ground, is the best size for average conditions. The 4-in. drill

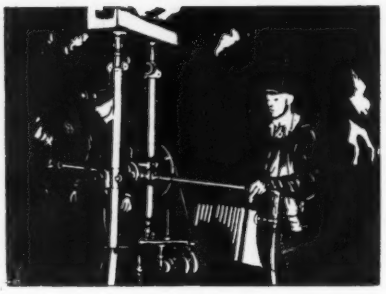
One of a series of articles on mine equipment.

is strictly a two-man machine. It weighs about 180 lb., and uses 1¼-in. round or 1⅛-in. hexagon steel, or larger, and is designed primarily for use in large drifts or tunnels in hard rock. A few 4½-in. drills, weighing about 225 lb., are used for special work, especially "deep-hole drilling," in which jointed steel is used and holes up to 150 ft. in depth are drilled. The standard mounting for these drills is on a cross arm between two columns.

Drills are mounted on saddles, or "clamps," in drifts and tunnels and in some stopes, and on horizontal bars or on arms attached to vertical columns. Bars and columns are nowadays almost always the same, the differentiation in name being a relic of the past, referring to the position in which they are used. They nearly all have single screws, only a very few double-screw columns being manufactured. When columns 12 ft. or more in length are necessary, it is hard to arrange the blocking at the upper end, and that end of the column is sometimes fitted with a ball-socket joint and a casting, to which a heavy rubber pad is fastened. This requires no blocking, and increases the speed and safety of setting up, but its use is not recommended for bars or short columns. Column arms are of the same diameter as the column, and the standard length is 22 in. Hammer drills do not require as large bars or columns as the old piston drills, and the 3- and 3½-in. drills work satisfactorily on bars only 3 in. outside diameter. The 4-in. machines should have 3½-in. bars. Saddle clamps for bars and columns should be of simple design, and the use of hook bolts should be avoided. The same applies to tripods, used in some stoping operations. Tripod weights are seldom needed.

A drill mounted on an air-feed leg is called a "stoper," because this type of drill was designed primarily for overhead work, such as raising and back stoping. To have the air-feed cylinder attached at its upper end directly to the backhead of the drill is standard practice, the air-feed piston rod extending through the lower end; but "reverse-feed" stopers are furnished, in which the piston rod is attached to the backhead of the drill, and works through the upper end of the air-feed cylinder. This construction permits clamping the air-feed cylinder on a bar and the use of this type of machine for drilling flat holes with hollow steel.

Most stopers are rotated by hand and use solid steel, ⅞-in. quarter octagon being a favorite section. There is an anvil block in the chuck, and no collar or lugs are needed. Hand-rotated wet stopers using hollow steel have never been popular, because the water drips continually on the operator's hands and arms. In some places an outside spray of water is played on the collar of the hole to kill the dust. If this is not



done the drillers should wear respirators, in which the dust is caught in a wet sponge. Self-rotating stopers are nearly always wet. They are heavier than the hand-rotated machines, and maintenance charges are considerably higher, but they require less effort to run, and will on the average drill more feet of hole per shift. They are increasing in popularity. Some of the smaller, self-rotating, hand-held drills have been mounted on air-feed legs for use in stoping and raising under special conditions, and have met with conspicuous success.

Hand-rotated stopers weight 60 to 90 lb.; self-rotating stopers, 80 to 120 lb. The hammer cylinder is 2½ to 3 in. diameter. The length of feed is about 2 ft., and the over-all length extended is 70 to 80 in. This length under ordinary stoping conditions is the maximum depth to which a hole can be drilled upward in the back.

Self-rotating, hand-held drills of the jackhammer type have cylinders of various diameters, from 2¼ up to 3 in. Hand-held machines larger than this have been used, but the rotation is too strong for one-man operation. Their weight varies from 37 to 115 lb. The lightest machines are used dry with hollow steel in drilling blockholes, cutting hitches; and a special type, weighing less than 40 lb., having a strong rotation and a fairly light blow, is used with solid twisted auger steel for drilling soft ground. This machine has a much wider application than is generally realized, and is effective in ground ordinarily considered to require a heavier wet machine and hollow steel. This drill mounted on an air-feed leg is very efficient in raising in soft or sticky ground.

The standard jackhammer weighs 40 to 45 lb., has a cylinder 2½ to 2¾ in. diameter, and is used either wet or dry with hollow steel. It is an excellent machine for sinking in medium ground and for underhand stoping, especially in sublevel stoping. In drifting, jackhammers having special mountings on shells were popular for a time, but their place has been taken by the more powerful 3-in. standard drifters. In medium ground, however, unmounted jackhammers are widely used for drilling flat holes. Several methods of support are in vogue. In South Africa one "boy" holds the machine on his shoulder while another runs it. In the copper mines of Arizona the drill is supported by a small iron hook, which has an eye of the right size to fit over the shank of a piece of ⅞-in. drill steel. A piece of steel of the appropriate length is stood up with the shank upwards, and the eye of the hook is supported on the collar of the steel, the hook being passed under one of the side rods of the drill. In a similar way, 2 in. x 6 in. plank of suitable length, notched at one end to receive the cylinder of the drill, is used in the Lake Superior Iron Country to support the drill in drifting on sublevels. Three pieces of plank of different lengths are required. A pair of pulley blocks with ⅜-in. hemp rope is used in some places for the same purpose. Of these different devices the hook and drill steel seem to be the simplest and best.

In shrinkage stoping, jackhammers mounted on air-feed legs have taken the place of stopers at Mount Hope, N. J., and have proved a great success. Deep, fairly flat holes are drilled in the back, the drill lying on its side on a plank, which rests at one end or both ends on a short ladder. The end of the feed-leg engages a short eyebolt stuck in a hole in the plank, and this bolt is moved up to a new position as the steel is fed deeper into the hole.

A paving breaker, virtually a hand-held heavy sinker without rotation, weighs about 65 lb. It drives a pointed wedge or gad, made of 1⅛-in. hexagon solid steel, with collar, and is fitted with a steel retainer. This type of machine is useful in medium ground for breaking chunks on grizzlies without blasting, and in mining parlance is called a "chunk buster." In ground too hard to break with a moil, a chunk can be broken often by drilling a 2-in. hole all through it with a jackhammer, and then driving a 2¼-in. wedge into the hole with a paving breaker. This method of breaking chunks is desirable in places where blasting would interfere seriously with the work of other men.

Air hose is wrapped or braided. In wrapped hose the reinforcing fabric is a continuous sheet of cotton cloth, wrapped in a spiral and impregnated in the rubber; in braided hose the reinforcing is actually woven or braided in place. Braided hose has the heavier fabric, and hence requires fewer plies for the same strength; but, because the threads lie diagonally and not straight around, it is more likely to swell under pressure. Inside is a lining of oil-proof rubber about ⅛ in. thick, and outside is a tough rubber cover of about the same thickness. Wire-wound hose is not as durable or flexible as rubber-covered hose, and is not recommended for mining work.

One-inch, 6-ply wrapped or 4-ply braided air hose is standard for all drifters and sinkers and for the larger stopers, and ¾-in. hose of the same construction for small stopers and auger

drills, but it is often advisable to use 1-in. hose for all sizes and types of drill in the mine. Water hose should be ½-in. diameter and of the same strength as the air hose. Hoses are ordinarily bought in 50-ft. lengths, but 35-ft. lengths will often do as well, and the saving is considerable. If a standard length is adopted, hoses should be bought made up in this length with capped ends.

Of many designs of hose clamps, nipples, and couplings on the market, some are very satisfactory. In general, however, they are heavy. Many companies prefer to use standard pipe fittings and wind the hose with wire instead of using clamps; ¾-in. nipples, ground a little at one end, so as not to cut the lining of the hose, and oiled or moistened before being inserted, are used for 1-in. air hose, and ⅜-in. nipples for ½-in. water hose. Unions of railroad type, having malleable iron bodies and brass seats, require no gaskets and are inexpensive. Stopcocks that have the cone reversed—with the handle attached to the small end—are tightened by the air pressure, and are as satisfactory as valves for the air line. The water hoses, however, should have special compression valves with soft rubber renewable seats.

Water under a head of 100 to 300 ft. must be furnished for wet drills. Usually the mine water, if caught near its source, is satisfactory; but occasionally it must be piped into the mine. One of the simplest methods of regulating the pressure is to set up in the shaft, or on the levels at vertical intervals of about 200 ft., a series of tanks or barrels, which will overflow into each other. The outlet is placed about 1 ft. from the bottom of the tank, so as to provide a sump for the settlement of sediment. The flow need not be large, because the consumption of water per drill is normally only 25 to 35 gal. per shift. Main-line distributing pipes are usually 1½ in. diameter, the size being reduced on branches till it is ¾ in. in the stopes. In isolated places, where water can be collected, a pressure tank, in which compressed air is turned in on top of the water, gives satisfactory service; 18-gal. tanks for this purpose are sold by drill makers, but any small tank available, such as a kitchen hot-water boiler, can be used.

In drifts or tunnels with over two drills separate manifolds for air and water should be used. The air manifold is made of a tee and two short pieces of 3-in. pipe, into the side of which the necessary ¾-in. nipples are welded. Each nipple is fitted with a stopcock, and connection with the hoses and the air main is made with unions. The water manifold is made similarly, but of smaller pipe.

A service car is a great convenience for fast driving. This is brought in close behind the drill carriage, if one of these is used, and on it are mounted air and water manifolds, line oilers, two floodlights, a small air receiver, and, if needed, a water-pressure tank. Racks are also provided for sharp and dull steel, tools and drills, and hooks for the hoses. Connections are made with the air and water mains by large hoses.

In estimating the number and selecting the size and type of drills and accessories needed, the mining system requires first consideration. An estimate is made of the number of stopes or working faces and the number of gangs needed to give the desired production, and from this estimate the number of drills is calculated. The amount and kind of concurrent development needed to maintain this production is then estimated, and from these figures the equipment necessary is calculated also. Shaft-sinking and main-level development will be completed to a large extent before production starts; and, if the equipment used in this work has been selected with this idea in view, much of it can be transferred to stoping and concurrent development as the work for which it was purchased is completed. A detailed schedule of operations is a great help in preparing the estimates.

Improvement in the quality of drill steel has been rapid in recent years. Alloy steels have been tried and have some advantages, but straight carbon steels are apparently holding their own. The amount of carbon varies from 0.70 to 0.95 per cent, and 0.84 per cent seems to be about right. Steel lower in carbon than 0.70 per cent is difficult to harden sufficiently, and that higher than 1 per cent is brittle. More careful regulation of the subsequent finishing temperature in rolling and heat-treatment have resulted in much longer life, and the accuracy of rolling has been increased. Steel should never be oversize, and $\frac{1}{64}$-in. undersize is sufficient allowance to make for variations in the rolls.

Size, shape, and position of the hole in hollow steel are now accurately controlled, and off-center holes are rare. By new processes also the hole is now almost perfectly smooth. This has reduced breakage, because most fatigue cracks start in the hole. The hole is usually ¼ in. diameter in the smaller sizes and $\frac{5}{16}$ in. in the larger sizes of steel.

Standard sections of hollow drill steel are 1⅛ and 1¼ in. round, ⅞ and 1 in. hexagon, and ⅞ in. quarter octagon; 1⅛ and 1¼ in. hexagon and 1 in. quarter octagon are used to some extent, but not in general practice. In solid steel, ⅞- and 1-in. hexagon and ⅞-in. quarter octagon are standard sizes for stopers. Twisted auger steel has two standard sections—a diamond section ⅞ in. by 1½ in. on the diagonals, twisted 2½ full turns to the foot, and a round section, having spiral flutes about $\frac{5}{16}$ in. high, rolled about it at approximately the same pitch. The latter section is furnished hollow, but is seldom used. The diamond section is to be preferred for most conditions. It is the more durable if the weight is not less than 2½ lb. per running foot. A rectangular section 1½ in. by ⅜ in., twisted like the diamond section, is sometimes used in soft ground.

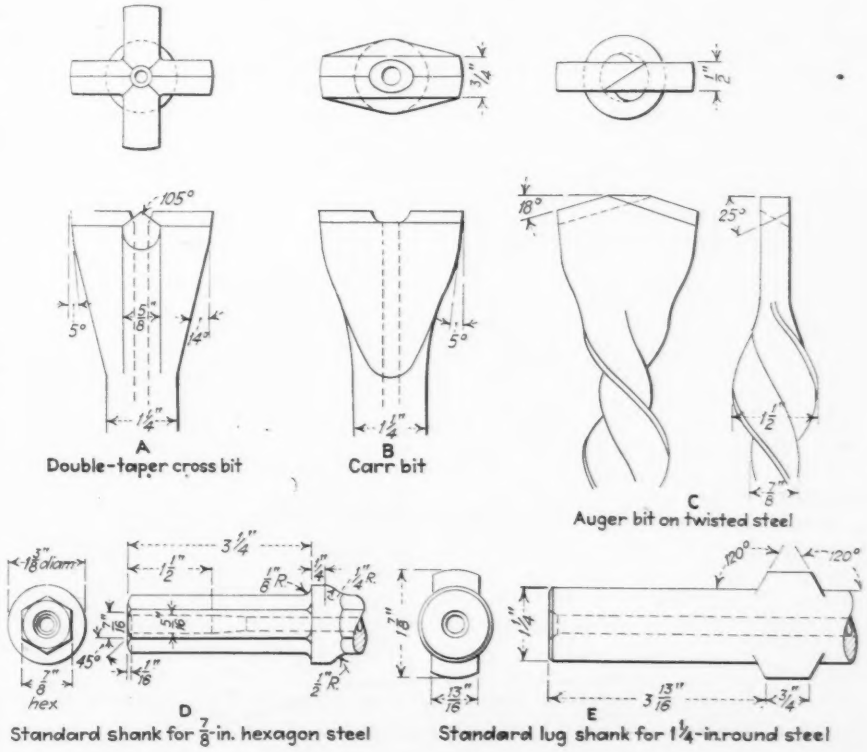


Fig. 59—Types of bits and shanks

The standard bit for hollow steel is the double-taper cross bit, having a taper of 5 deg. for a short distance back from the four corners, and 14 deg. from there on. Usually, the angle of the cutting edge is 90 deg., but for hard ground it may be advantageously increased to 105 deg. The wider angle provides more backing for the cutting edge and makes sharpening easier. The thickness of the wings is important; and, except in soft ground, it should not be less than ½ in. In hard ground, bits on 1¼-in. steel should have wings ⅝ in. thick. If the wings are too thin, the corners of the bit will be broken off. The wings, however, should not be made so thick that insufficient clearance is provided for the cuttings to pass freely between them. The hole is usually flared in the bit, and this often increases drilling speed; but, if the hole tends to be plugged, as often happens in soft ground, it can be closed entirely in front and be opened from the side between the wings an inch or so back from the cutting edge.

The Carr bit, a single bit with 120 deg. cutting edge, an enlarged hole, and a slight taper at the corners, has advantages in hard ground, especially on ⅞-in. hexagon steel. The diameter of the bit can be kept small, and at the same time proper clearance for the cuttings can be provided without reducing too much the thickness of the wings. It is a hard bit to sharpen, however, especially in the larger sizes, and a good many bits have to be cut off in the shop, with resulting loss of steel.

Especially important is the shape of the bit on auger steel. The bit probably best for average conditions has a single cutting edge, high in the center, as shown in Fig. 59 (*C*). If the center is cut away, leaving an opening ½ in. wide, drilling speed in rubbly ground is materially increased. These bits can be sharpened by hand or machine.

Standard shank for ⅞-in. hexagon or auger steel in the United States is 3¼ in. long and ⅞-in. hexagon in section, and has a round collar 1⅜ in. in diameter. It is shown in Fig. 59 (D). On 1-in. steel the shank is 4¼ in. long. In some places square shanks are forged on round steel. The standard shank with lugs is shown in Fig. 59 (E). The lugs are usually forged directly on the shank, but are sometimes welded on or built up with an electric arc welder. Fairly simple shanking devices are furnished for standard drill sharpeners.

Upsetting the steel in forging lugs or collars weakens the structure, and the forging heat destroys the effect of the finishing temperature in rolling, and creates a line of weakness, which may be removed by heat-treating afterward. To avoid this weakening effect, a rubber collar was invented and patented by J. Daniel, of Johannesburg, South Africa, and it is in use at some of the Rand mines. A short piece of air hose is forced over a wet shank to the proper position, and a soft steel band is tightened around it by swaging in the sharpener. The rubber will not slip if it is kept dry, but cannot be used in places where it will be wet. Weakness caused by forging lugs on drifter steel may be avoided by using collarless hexagon steel and anvil-block chucks.

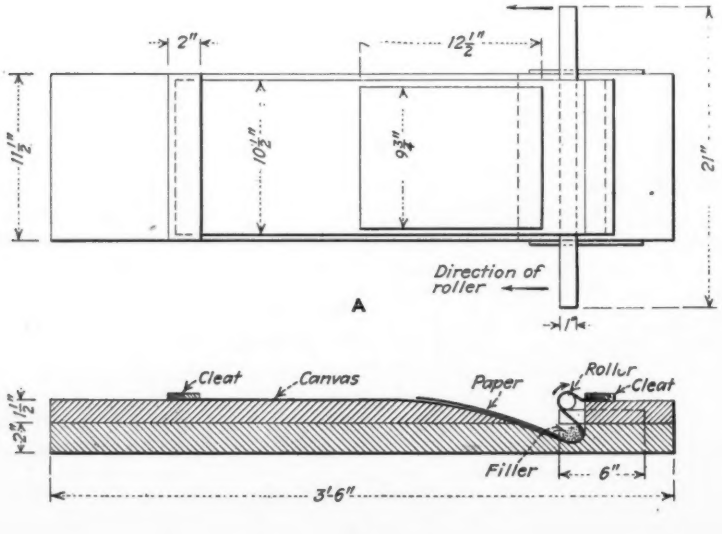
(*To be continued*)

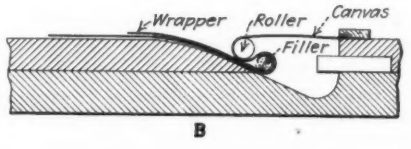
Device to Make Wrapped Stemming

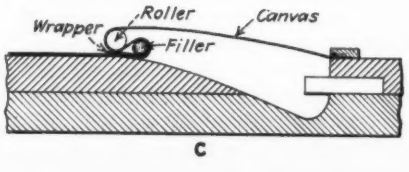
THE importance of tamping with good stemming is generally recognized, but a supply of wrapped stemmings is seldom at hand when the round is to be tamped. Most miners, if they do not have a supply of good stemmings at hand, will tamp a round with an extra stick of powder in each hole. In a shaft with a round of 20 holes, assuming a cost of 10c. per stick of powder, a saving of $2 per round would be effected if good stemming were used. The accompanying drawing illustrates a machine devised by Quentin S. Tracy, a student at the University of Washington, which with little labor can be used to provide a supply of good stemmings.

The machine may be made as shown in the diagram. Old catalog sheets make good wrappers; damp tailing makes the best filler. The roller, which may be made from 1-in. water pipe, should be of the same diameter as that of the finished stemming; 8- to 10-oz. canvas is about the best weight.

The operation consists of setting the roller under the canvas in the position shown in the diagram. A handful of filler is placed in the notch and a wrapper is put on the canvas. The roller is drawn and rolled in the direction indicated by the arrows. In position *B* the paper is just starting to wrap around the filler. In position *C* the paper is almost completely wrapped around the filler. When the rolling is completed, the ends of the wrapper are closed and the result is a stemming about 1¼ in. diameter and 8-in. long. The finished stemmings may be put in a powder box and stored in a drift ready for use.



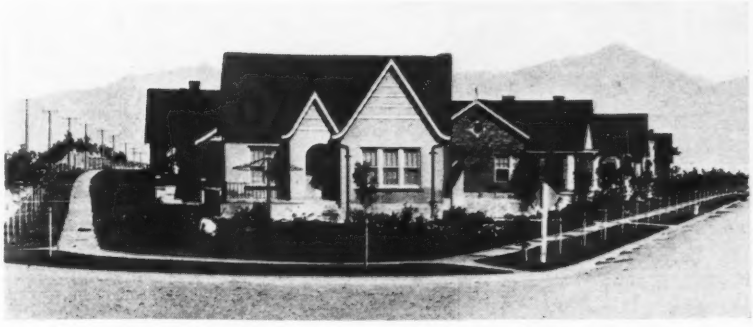




Employee Housing—V

A. H. Hubbell

Associate Editor



Typical one-family dwellings, Copperton, Utah. Foremost house is shown in plan in Fig. 44

HOUSING of Utah Copper Company, Copperton and Bingham Canyon, Utah. At the mouth of Bingham Canyon, where it opens into Salt Lake Valley, the Utah Copper Company has laid out an attractive townsite for the families of its mine staff, technical employees, foremen, shovel runners, railroad engineers, and mechanics and other employees of similar status. The town, known as Copperton, is about three miles from the mine. Everything has been done to make living conditions as agreeable as possible. Streets are graded and curbed and lined with concrete sidewalks. Each house has its lawns and shade trees. Up to the present, 127 houses have been provided. Population is approximately 500. Facilities provided include a community park, a children's playground, tennis courts, and a baseball park. The county has built a grade school and a well-equipped modern high school. Houses are of brick or stucco on hollow tile, and copper and brass have been extensively used in their construction. Drawings detailing typical floor plans and type of construction are shown in Figs. 44 to 46 inclusive.

Near the mine, in upper Bingham Canyon, are provided several bunk houses at a site called Dinkeyville. These are illustrated in Fig. 47 and in a photographic cut. They are used for trackmen, principally Japanese and Koreans. Likewise, near the mine is a dormitory for single white employees, a four-story building of stucco and hollow tile, also shown in a halftone. Near the mine is an attractive clubhouse.

The climate at Copperton is dry. Average summer temperature is about 85 deg. F., and the maximum about 100 deg. F. The average in winter is 25 deg. F., with the minimum a few degrees below zero.

Average yearly precipitation is 15 in., a large part being snow. During the winter, precipitation averages about 1.5 in. per month, and in summer about 0.7 in. monthly.

Fig. 44 shows foundation and floor plans of a five-room house, typical of the rest in construction. The exterior of this particular model may be seen in the cut at the left. This house has a concreted, well-lighted basement, divided into furnace, coal and storage rooms, and laundry.

Fig. 45 shows the floor plan of a four-room dwelling and Fig. 46 a section typical of the houses in general.

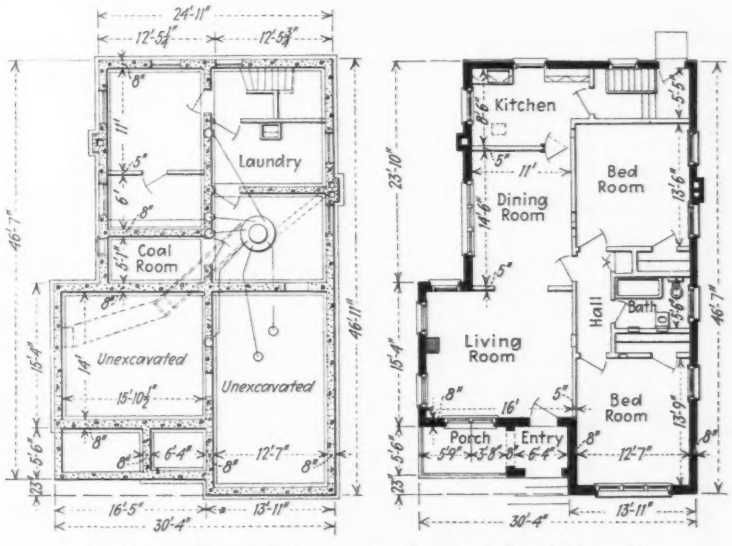
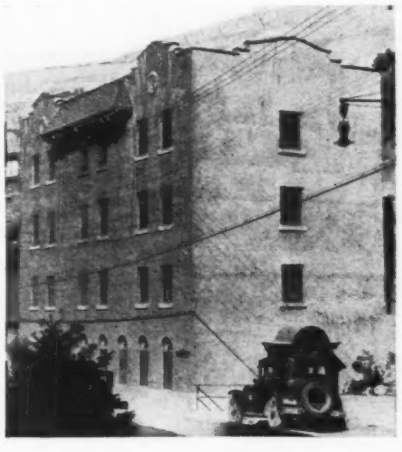


Fig. 44—Typical five-room house, floor and foundation plans, Copperton



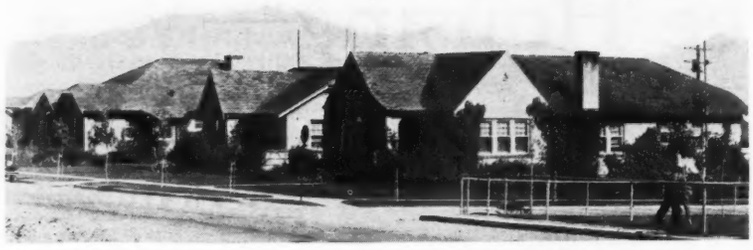
Dormitory, upper Bingham Canyon, Utah Copper Company

Hot-air heat, electric light (purchased from the public utility company), and running water, supplied from wells half a mile up the canyon, are provided. Electricity is supplied through underground conduits, to avoid disfiguring the streets with poles.

Copper has been generously used. Roofing is of so-called Flintcote Copper-clad Giant shingles. Elsewhere, the metal is used for valleys, hips, ridges, flashing, downspouts, gutters, chimney saddles, plumbing (brass), kitchen and toilet vents, screens, and building hardware. As estimated by the company in 1928, this extensive use of copper increased the average first cost of these houses by $310, which additional expenditure was considered warranted because of the lasting quality of the metal.

Cost of the four-room houses, illustrated in Fig. 45, was $5,058 each, or $1,265 per room, or $0.64 per cubic foot. The corresponding figures for the

Previous installments have dealt with employee housing in Northern Rhodesia; Newgulf, Tex.; Matahambre, Cuba; Achotla and Monterrey, Mexico; Pecos Valley, N. M.; Trona, Calif.; Tyrone, N. M.; Clarkdale, Ariz.; Northern Manitoba; Mount Isa, Queensland, Australia; and Chuquicamata, Chile.



Other typical one-family houses, Copperton

five-room houses, shown in Fig. 44, was $5,536 per house—that is, $1,107 per room, or $0.63 per cubic foot. In estimating the cost per room, the furnace room, coal room, laundry room, and store room in the three-quarter finished basement were ignored, although their cost is included in the figure representing the cost per cubic foot.

The grouping of the bunk houses at Dinkeyville, in the upper canyon, may be seen in an illustration. The buildings that house the dining room and wash room are marked "1" and "2," respectively. Each bunk house has eight rooms, with accommodations for two men per room. As indicated in the section in Fig. 47, outer walls are of brick and hollow tile, with steel-angle lintels over all openings. Roofing is of Copperclad strip shingles. Interior partitions are of lath and plaster. Earlier buildings erected for a similar purpose were of frame construction. Permanency has been the objective in recent building.

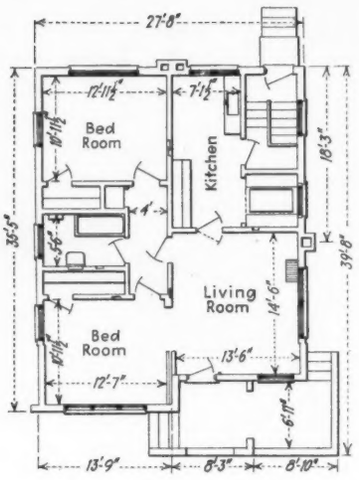


Fig. 45—Floor plan of four-room houses, Copperton

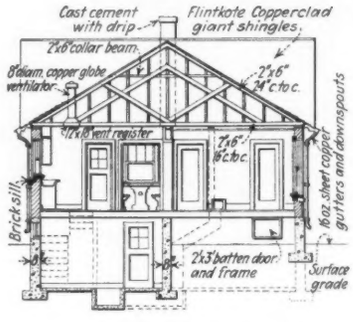


Fig. 46—Typical section, four- and five-room houses, Copperton

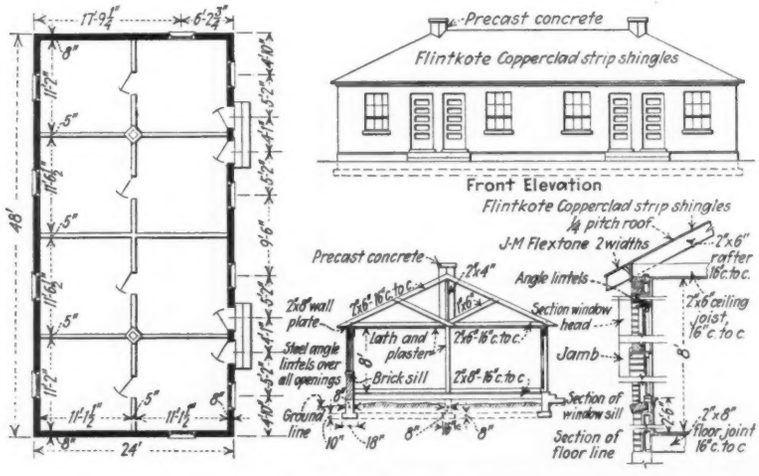


Fig. 47—Bunk houses, upper Bingham Canyon. Floor plan, elevations and sections

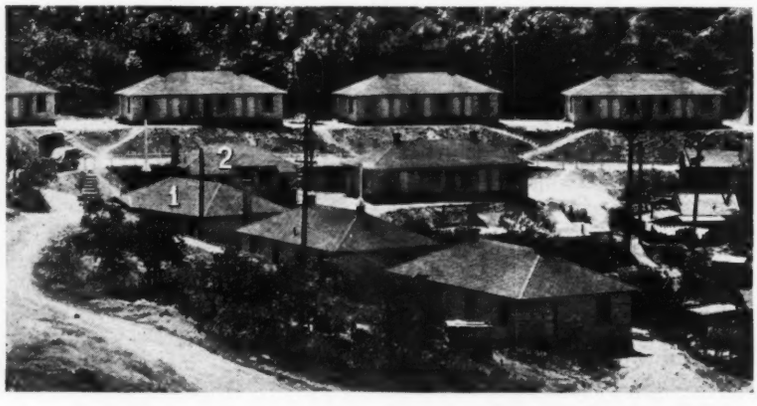
The wash room, Fig. 48, serving the bunk houses, has a floor of concrete and a ceiling of diamond metal lath. The building which houses the dining room and kitchen is 48x24 ft. outside, the dining room being 23x35 ft. This building is in general like the others.

Cost per bunk house of eight rooms was $3,500, or $0.39 per cubic foot. The building housing the dining room and kitchen cost $3,300, or $0.38 per cubic foot. The wash-room building (Fig. 48) was more expensive, costing $5,900, or $1 per cubic foot.

The dormitory, situated at the mine, is a four-story building 27x58 ft. in size and built of stucco and hollow tile. It is shown in a cut on the preceding page. On the ground floor are a kitchen, dining room, and sitting room. Half of the second floor is laid out as an apartment, consisting of a sitting room, three rooms, and a bath, with a central hall. The rear half of this floor has four individual rooms and a bath. The third and fourth floors have each ten rooms and separate bath.

Housing of the Nevada Consolidated Copper Company, Ruth, Nev. Except for a few months during the winter, the climate at Ruth is moderate. During the hottest summer weather, the temperature ranges from 90 to 100 deg. F. In winter, the thermometer will drop at times to 20 deg. F. below zero. Precipitation averages 10 in. annually and consists of snow save for an occasional summer thunderstorm.

All classes of employees are housed in practically the same type of building,



Bunk houses, upper Bingham Canyon, Utah Copper Company. Building 1 houses the dining room and kitchen. Building 2 the wash room

foreign laborers in a separate townsite. The dwellings rented by the company to employees consist of two-, three-, and four-room frame houses, such as are shown in Figs. 50 and 51, which are allotted to married employees, and dormitories, shown in Fig. 49, for single men. According to the management, a four-room house, illustrated in Fig. 50, has been found most satisfactory for families, and the 24-man bunk house, Fig. 51, for single men. The approximate cost of one of the four-room houses is $2,500, and that of a 24-man bunk house, $3,400.

A bill of material is given for the bunk house shown in Fig. 49. As will be

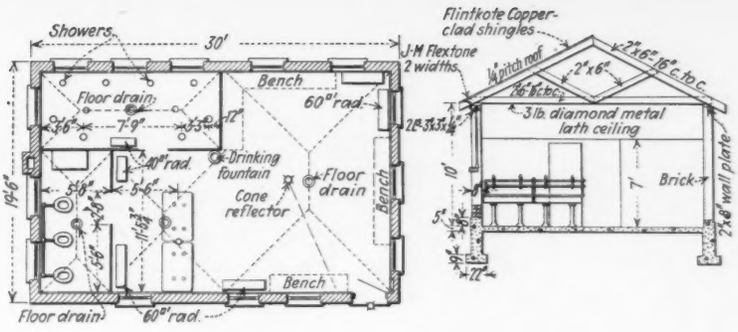


Fig. 48—Washroom building serving bunkhouses, upper Bingham Canyon. Floor plan and section

Bill of Material for One 24-Man Bunk House, Shown in Fig. 49, Nevada Consolidated Copper Company

300		Pads, 2 in. x 12 in. x 2 ft. fir
40		Underpinning, 4 in. x 4 in. x 8 ft.
650	Lin.ft.	Sub-sill, 4 x 6 in.
120	F.B.M.	Floor joists, 2 x 8 in. x 16 ft.
3000	F.B.M.	Sub-floor, 1 x 12 in.
3750	F.B.M.	Fir flooring
519		Studs, 2 in. x 4 in. x 9 ft.
2634	Lin.ft.	Plates and bracing, 2 x 4 in.
100		Ceiling joists, 2 in. x 6 in. x 16 ft.
125		Rafters, 2 in. x 4 in. x 20 ft.
4900	F.B.M.	Sheeting, 1 x 12 in.
3900	F.B.M.	Rustic
260		Frieze, 1 x 6 in.
260		Frieze, 1 x 3¼ in.
260	Lin.ft.	Quarter round
8	Pieces	Pine corner board, 1 in. x 4 in. x 12 ft.
8	Pieces	Pine corner board, 1 in. x 3¼ in. x 12 ft.
15	Rolls	Building paper
250	Lb.	Nails
1176	F.B.M.	Wainscoting
192	Pieces	Compo board, 4 x 9 ft.
84	Pieces	Compo board, 4 x 6 ft.
64	Pieces	Compo board, 4 x 5 ft.
6	Pieces	Compo board, 4 x 12 ft.
3	Pieces	Compo board, 4 x 6 ft.
1844	Ft.	Cove mold
2042	Ft.	Lattice strip
720	Ft.	Pine base, 1 x 7¼ in.
880	Ft.	Quarter round
260	Ft.	Wainscote mold
49	Squares	Brooks roofing, 4-ply
500	Ft.B.M.	Flooring for porch floor
800	Ft.B.M.	Ceiling for porch
8		Porch posts, 5 in. x 5 in. x 6 ft. 8 in.
460	Ft.	Quarter round
16		Standard cottage windows and frames complete
3		Standard bath-room windows and frames complete
15		Doors and frames complete, 2 ft. 8 in. x 6 ft. 8 in., 5-panel
12		Panel doors and casings complete, 2 ft. 4 in. x 6 ft. 8 in., 5-panel
1		Glazed door, frame and casing complete, 2 ft. 8 in. x 6 ft. 8 in.
16		Standard window screens
1		Standard screen door, 2 ft. 8 in. x 6 ft. 8 in.
3024		Brick for the chimney
1		Transite switch cabinet, 3 in. x 2 ft. x 2 ft.
78	Sq.yd.	Battleship linoleum
3	Sq.yd.	Concrete, stove base and bath-room floor
1600	Lb.	Paint
1		Frost-proof toilet
1		Shower and mixing chamber
1		Wash basin, 8 ft.
2		Floor drains, one in shower room and one in wash room
6		Faucets, ½ in., four nickel plated and two brass.
50	Ft.	Black wrought pipe, ½-in.
7		Ells, ½-in.
3		Ells, ½-in., 45-deg.
2		Ells, ¾-in.
3		Ells, ¾-in., 45-deg.
15	Ft.	Pipe, ¾-in.
2		Gate valves, ¾-in.
2		Tees, ¾-in.
1		Union, ¾-in.
1		Gate valve, ½-in.
2		Tees, ½-in.
1		Union, ½-in.
1		Ell, ½-in., 45-deg.
40	Ft.	Soil pipe, 4-in.
1		Clean-out, 4 in.
1		Clean-out, 2-in.
1		Trap for toilet, 4-in.
1		Trap for sink, 2-in.
15	Ft.	Pipe, 1½-in.
2		Bends, ¼, for 4-in. soil pipe
2		4 to 2 Y's
2		Bends, 45-deg., for 4-in. soil pipe
10	Lb.	Oakum
25	Lb.	Lead
1		Galvanized hot-water boiler and stand, 100-gal., with relief valve and boiler union for cold-water supply
1		O-9 Ideal hot-water heater
252	Ft.	Pipe, 2-in.
252	Ft.	Pipe, 1½-in.
24		Tees, 2-in.
12		Gate valves, ¾-in.
24		Unions, ¾-in.
12		Ells, ¾-in.
12		Tees, 1¼-in.
12		Reducers, 1¼ to ¾-in.
1		Gate valve, 2-in.
1		Union, 2-in.
1		Ell, 2-in.
3		Ells, 2-in., 45-deg.
2		Pet cock, ¼-in.
20	Ft.	Pipe, 1½-in.
3	Ft.	Pipe, 1-in.
2		Unions, 1-in.
13		Wall-type radiators with hangers, 30 sq.ft.
40	Ft.	Conduit, ½-in.
30	Ft.	Conduit, 1-in.
8		Lock nuts, ½-in.
8		Bushings, ½-in.
2		Lock nuts, 1-in.
2		Bushings, 1-in.
4		Double-pull single-throw 30-amp. 125-v. cutouts.
8		Plug fuses, 15-amp.
20		Keyless receptacles with 10-in. porcelain enameled shades
26		Angle-pull chain sockets, two for each room
26		Hubbell reflectors, 30-deg., aluminum inside, green outside
15		Snap switches, 5-amp. S.P.
50	Ft.	Circular loom, ½-in.
224		Split Nailit knobs, No. 5½
650	Ft.	Solid R. C. wire, No. 14
150	Ft.	Solid R. C. wire, No. 10
1½	Lb.	Wire solder
2	Lb.	Manson tape
2	Lb.	Rubber tape
½	Lb.	Soldering flux
10		Pipe straps, ½-in.
4		Pipe straps, 1-in.

noted in this table and in the drawing, no special provision is made for insulation against heat or cold.

A multi-family block of apartments is illustrated in Fig. 52. Two apartments only are shown. The framing of this structure consists of 2x4-in. studding, spaced 16 in. except as noted; 2x8-in. floor joists, spaced 18 in.; 2x6-in. ceiling joists on 24-in. centers; and 2x4-in. rafters, spaced 24 in. apart.

Housing of Anaconda Copper Mining Company, Conda, Idaho. Fig. 53 shows the type of dwelling provided by the Anaconda company for employees at its phosphate plant at Conda. Dwellings

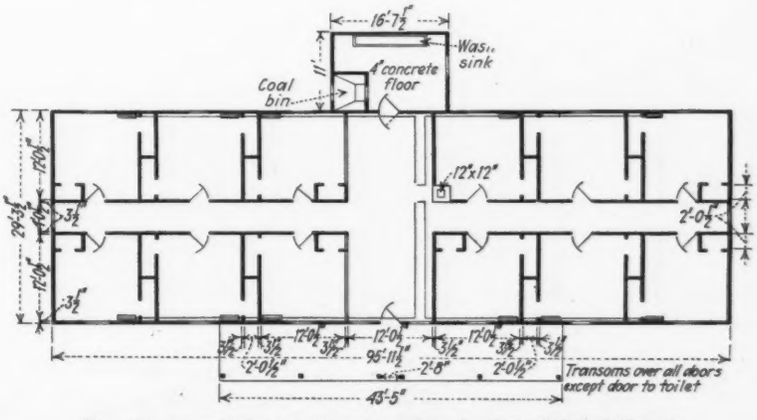


Fig. 49—Dormitory for 24 men. Nevada Consolidated Copper Company, Ruth, Nev.

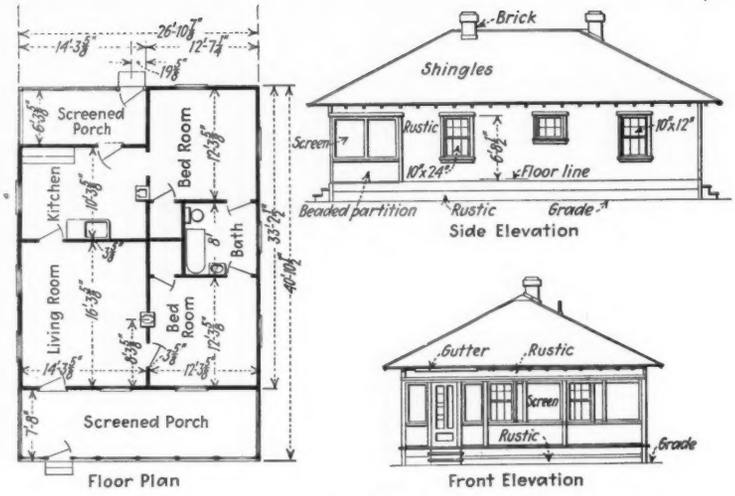


Fig. 50—Four-room frame dwelling. Floor plan and elevation, Nevada Consolidated Copper Company, Ruth, Nev.

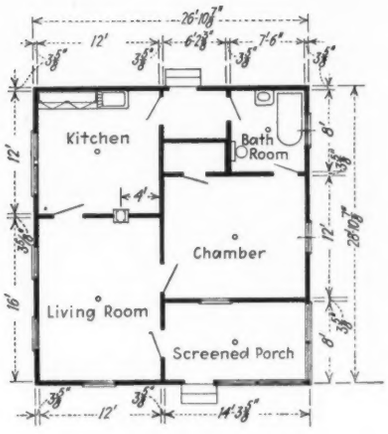


Fig. 51 — Three - room house, floor plan, Nevada Consolidated Copper

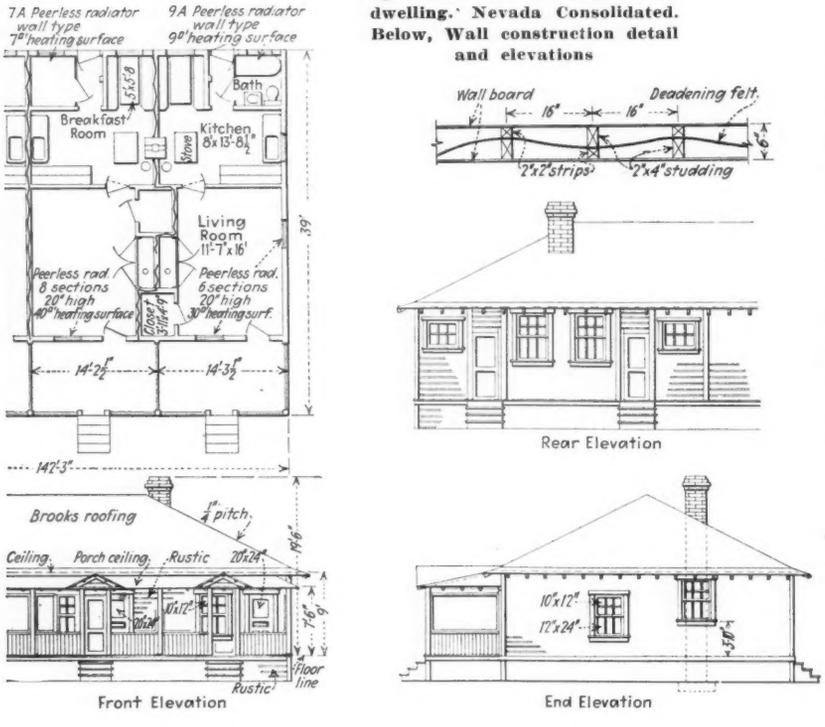


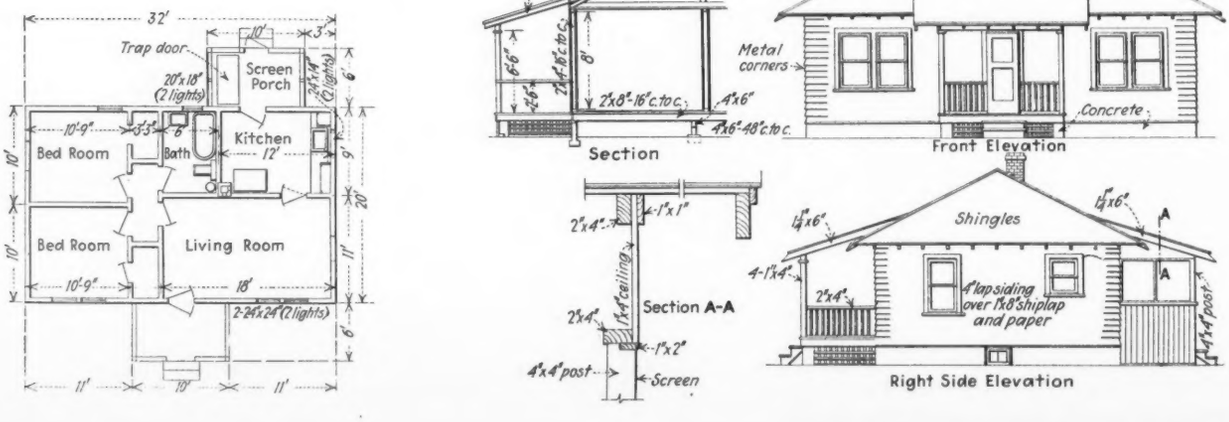
Fig. 52—Left, Floor plan of two apartments of 10-apartment dwelling. Nevada Consolidated. Below, Wall construction detail and elevations

of this type serve to house the married white employees, including technical men and workmen. The town is situated at 6,000 ft. elevation. Average mean summer temperature is 64 deg. F., and average mean winter temperature 20 deg. Annual precipitation averages 13 in., of which 3½ in. is rain and the remainder snow. Average annual snowfall is 72 in.

The approximate cost of these houses was $1,800, in the year of erection The foundations are of concrete; framing is of Douglas fir, siding of pine or cedar, roofing of cedar or mineral-surfaced composition or Copperclad shingles. Inside walls are of gypsum board or plaster. For protection against cold, felt paper or Sisalkraft is used between the wall sheathings. Protection against vermin is gained by closing all cracks or joints with plaster.

The houses are equipped with modern plumbing, and connected to the water and sewer systems of the townsite. They are wired for 110 volts alternating current for lighting and cooking purposes, and are heated by coal stoves provided by tenants.

Fig. 53—Typical dwelling Floor plan, elevations and sections, Anaconda Copper Mining Company, Conda, Idaho.



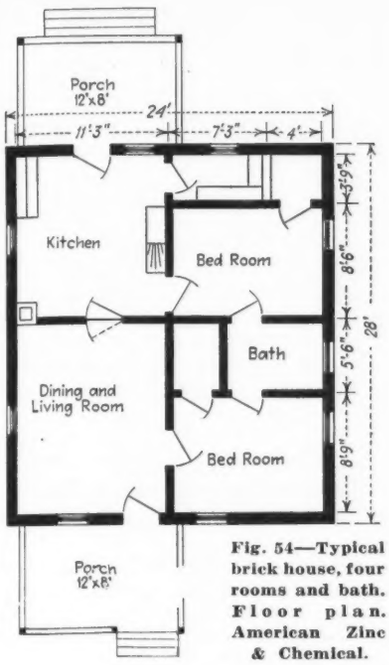


Fig. 54—Typical brick house, four rooms and bath. Floor plan. American Zinc & Chemical.

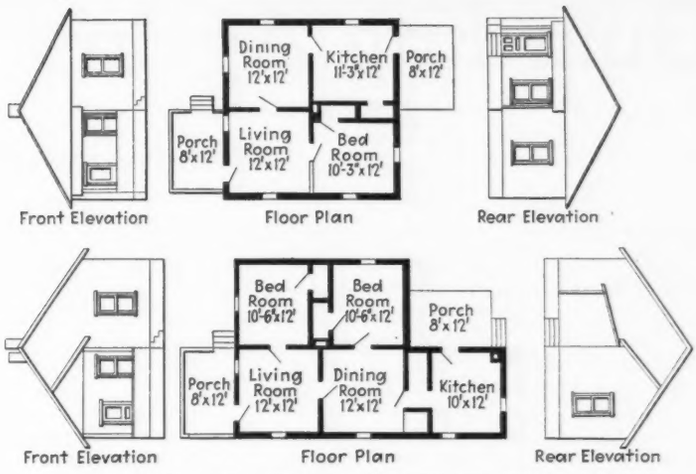


Fig. 55—Four- and five-room brick veneer houses, without bath, Langeloth

Housing of American Zinc & Chemical Company, Langeloth, Pa. Langeloth has an average summer temperature of 71 deg. F., and an average winter temperature of 33 deg. F. Annual precipitation averages 36 in., of which 11 in. fall during June, July, and August. The company provides housing accommodations for all classes of its employees, most of whom are married and of workman status. All are white.

To meet the varying income from wages, several types of houses have been erected. Roughly, these may be considered in two classes—namely, four-, five- and six-room houses, furnished with hot and cold water, toilet, and bath. These cost about $400 per room when erected in 1915. The others are four-room houses without water, toilet, and bath, the cost of which was about $300 per room in the same year. The first of these houses is typified by the design in Fig. 54; the second by Fig. 55.

With respect to both classes, foundations are generally concrete to the ground line and brick or building tile above. Framing is yellow pine. Where the houses are of wood, the side walls consist of sheathing, building paper, and lap siding on 2x4-in. studding. In the brick-veneer houses, the walls are of 4-in. red brick outside the 2x4-in. studding. Side walls of the stucco houses consist of sheet zinc laid on 2x4-in. studding, followed by wood strips, expanded metal lath, and portland cement stucco. Roofing of the wood houses consists of cedar or asbestos shingles. Rag-felt shingles are used on the brick and stucco houses. Side walls in general are of lath and plaster or plaster board finished with plaster. No insulation against heat or cold is used.

According to the management, dwellings of the type shown in Fig. 54, including inside toilet and bath, are preferred, and if additional houses were to be built today these facilities would be included. They would, moreover, be of the bungalow type and would have five or six rooms with a finished basement containing laundry facilities and water heater, the ordinary hot-water boiler being sufficient to prevent freezing in the cellar. Consideration would be given to partitioning off part of the cellar or extending it under a porch so as to serve as a garage. Experience indicates that houses of this type of construction could be rented without difficulty. Preferred construction would be brick with hardwood floors, this resulting in the lowest cost of maintenance. If labor conditions should render brick construction uneconomical, the stucco type, previously described but with insulating material between the studding, would be a second choice. Wood houses of the ready-cut type have been found satisfactory. For roofing, the company has found rag-felt shingles covered with crushed slate most satisfactory. The type of heating plant to be employed is recognized to be a matter of choice. For houses of the bungalow type, the company prefers the hot-air furnace.

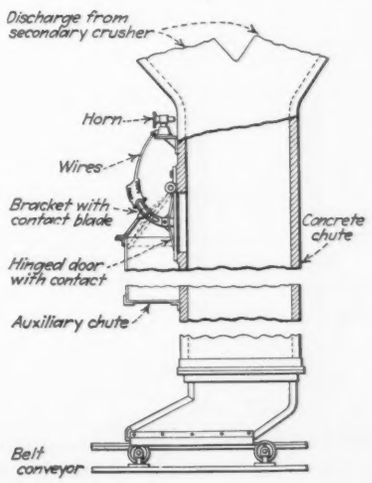
Potable water is supplied to all houses. Usually, this is piped directly into the house; otherwise to a hydrant in the yard. Electric light is furnished by the company. Houses occupied by staff members are equipped either with hot-air or hot-water heaters. In other cases, employees furnish their own stoves, using either coal or natural gas. The latter is piped to all houses. Langeloth has a complete sewer system and a sewage-disposal plant.

■

Automatic Overflow Signal

TO AVOID CLOGGING of the main discharge chute in the event of a belt conveyor failure, resulting in costly shutdowns, the mechanical department of New York Traprock Corporation developed and installed at its Haverstraw plant, near Newburgh, N. Y., the automatic signal illustrated in the accompanying cut. The device consists of a hinged trapdoor covering the aperture in the concrete wall of the chute; electrical contact equipment; a signal horn; and a small sheet-iron auxiliary chute. All live parts are insulated by fiber plates and washers.

In the event of a belt conveyor failure, the crushed rock discharged by the two 30-in. McCully crushers rises in the main chute until it reaches the trapdoor, which is then forced open by the pressure of the rock flowing into the auxiliar chute, thereby establishing a circuit between the contacts and blowing the horn, warning the operator in time to afford him an opportunity to shut down the crushers.



Guarding Against Mine Fires

Oscar A. Glaeser

MINING HISTORY of the past twenty-five years is punctuated with tragic and costly mine fires. Individual fires have taken from a few to more than 150 lives. These fires affected mining operations that ranged from temporary shutdowns and small repairs to expensive slime-filling programs and sealing of large areas, involving millions of tons of ore. The cost of mine fires is high. Although figures are not available, a safe assertion is that several American mine fires have exceeded the million-dollar mark in cost.

To be assured that no exaggeration of facts is made, one need but recall the North Butte fire in 1917, with its loss of 163 men; the Argonaut fire in 1922, with 47 lives lost; the Hollinger fire, with 39 lives lost; the Magma shaft fire, with 7 dead; the costly slime-filling program which had to be resorted to in the Tramway, Leonard, and West Colusa mines to extinguish fires before mining could be resumed in certain areas; the ground movement *en masse* following a fire in the United Verde mine, which has necessitated a stripping operation involving some 4,000,000 yd. of rock. The cost of these fires can only be guessed at.

Causes of metal-mine fires as listed by the U. S. Bureau of Mines in Technical Paper 314, "Causes of Metal-Mine Fires," by Dan Harrington, Byron O. Pickard, and H. M. Woflin, are presented in Table I. Since 1923, when that paper was written, the candle has practically disappeared, the carbide lamp taking its place. Electricity, on the other hand, finds more general application underground, and, in all probability, heads the list of hazards under present conditions. Another cause of fires which has developed since the publication of the data in Table I is the use of acetylene and arc welding equipment underground.

In recommending preventive and protective measures for mines, I feel that such recommendations must carry with them justification for their adoption more concrete in form than the assumption that fire hazards exist in most mines, and that these may at any time be translated into actual fires. To demonstrate the justification for fire protection in mines, I shall consider mining as a manufacturing enterprise, and attempt to determine what would be considered satisfactory protection were the mine a surface industrial plant.

Let us consider any modern factory. It is built of steel and concrete or brick. The interior naturally contains some inflammable material. Its product of manufacture may also be inflammable or even explosive. How extensive is the fire protection of such a plant? It usually includes: an automatic fire-alarm system, a special water system for fire fighting, fire plugs or hydrants with ample hose, fire escapes, fire extinguishers, possibly a chemical cart, a volunteer fire crew picked from employees, fire control doors on elevator shafts, periodic fire drills on the part of employees, and last, but far from being least, a well-trained city fire department maintained by taxation. All of these precautions are taken in spite of the fact that the structure is fireproof. In addition, automatic sprinklers may also be installed. With all of this protection, fire insurance is carried on the property and the goods in process. In what manner do such a plant and a mine differ that the former needs so much more protection than the other? The plant is on the surface. The safety of the employees and the fire-fighting crews is fundamentally greater in surface plants than underground. Accessibility to the fire is so much better on the surface that conditions there are not comparable with the confined character of those that exist in a mine. Is a mine consequently worth less, or can it be replaced or rehabilitated any more easily, than a factory of comparable size? If the answer is in the negative, then does any justifiable reason exist why a mine which has inflammable material in it should not be protected similarly, regardless of whether or not this material be in small, concentrated lots or spread throughout the mine?

Table I—Causes of Metal-Mine Fires

Cause	No. of Fires	No. of Men Killed
Candles in connection with timber	30	108
Carbide lamps against timber	3	0
Providing heat for various purposes, as warming oil or explosives	10	21
Spontaneous combustion	15	5
Burning surface structures, asphyxiating men or damaging mine workings	11	57
Electrical equipment	8	191
Incendiary	2	13
Revival of old fires	3	3
Explosives	4	5
Unknown	29	177
Totals	115	580

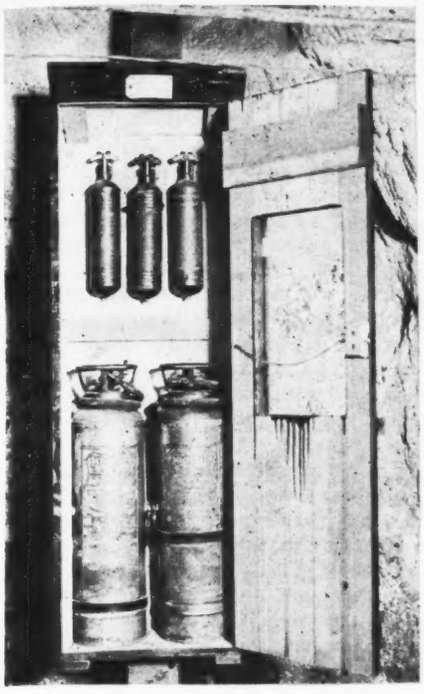
Table II—Insurance Rates on Various Structures

	Average Clause		
Type of Structure	90 Per Cent Total Value	80 Per Cent Total Value	70 Per Cent Total Value
Fire resistive office buildings	$0.38	$0.42	$0.47
Masonry walls, frame interior	0.76	0.81	0.86
Frame mill and factory buildings	$2.30 to $2.67 per $100		

Assume that the only inflammable part of a mine is a 1,000-ft. timbered shaft, through which the men must be transported and all the ore hoisted. A fire in such a shaft, unless the shaft were adequately protected, would do considerable damage, and would tie up production for a time. Would fire protection for such a shaft be worth while? Perhaps the question should be worded otherwise: Is the mine of such value that, in the event of fire, the management would abandon it? If the answer is "no," then fire protection should be installed; because, under the circumstances, the question has become one of economics, and a shaft sprinkler system is far cheaper than rehabilitating a fire-devastated shaft. Insurance to reimburse the owner for fire losses incurred is not obtainable on mines. As a mine cannot be insured, as shaft fires do occur, and as such fires have done great damage to property and cost many lives, the importance, necessity, and desirability of protection must be admitted.

To carry this reasoning a step further, let us assume that the value of a mine, based upon completely developed orebodies only, is $500,000, and that 60 per cent of this ore is being extracted by the square-set method, with 40 per cent requiring no timber in its extraction. Electricity is used throughout the mine for pumps, lights, slushing hoists, and small fans. The mine is fairly dry, and air circulation is natural. This mine is comparable with a manufacturing plant worth $500,000, 40 per cent of which is absolutely fireproof, and 60 per cent either containing inflammable material or of only partial fireproof construction.

Insurance rates in a Western state on various types of structures are presented in Table II. These rates are applicable to the manufacturing plant, which, within limits, is comparable with the mine. Thus, the 40 per cent fireproof part of the plant would without question carry the low rate. As nothing that will burn exists in this part of the mine, and as the product cannot be destroyed by fire, the assumption is made that no risk exists. Sixty per cent of the plant is covered by the second classification, and let us assume that an 80 per cent average clause is used, which, at $0.81 per $100 valuation applied to 80 per cent of the total value, would result in an insurance cost of



Underground fire extinguisher station
In an emergency the glass is to be broken and the door opened by pulling on small chain

$2,430 per year. The fire risk in a square-set stope, with its open lights, chips of wood, smoking, blasting, and the class of men employed, is certainly as great as in any structure built of masonry with a frame interior. The assumption is made that this sum of $2,430 is available annually to protect the mine against fire losses, and that, as the mine cannot be insured against loss from fire, the management decides to spend this money for protection.

Initial cost of water systems and protective equipment for the mine is assumed to be $8,000. This amount can be repaid with interest out of the insurance fund of $2,430 per year in three and a half years. Thereafter only a small part of this amount will be needed annually for extensions to water lines and for maintenance and repairs to equipment and pipe lines. Thus, the mine has been reasonably well protected and the protection financed through an annual assessment on the treasury, which, in a surface plant, would be paid out yearly for the life of the plant without question, and would be considered good and conservative business. This protection must be looked upon by the mine owner as his fire insurance on the mine, and its cost should be spread over a period of years.

Fire prevention, although the fundamental remedy for fires, is not enough for the protection of the mine and the property's surface plant. Protective and fire-fighting equipment and personnel are even more essential. The amount and character of such equipment should be in keeping with the size of the mine and the known fire hazards, and the mine staff should be organized for any emergency. Nothing is so ineffective as a helpless and excited group of men with strained nerves and eyes, standing on the fringe of a smoke-filled level, as if somewhere in that blackness lies the answer to their question: How to reach the fire?

Methods for fire prevention and protection in underground workings may be classified as follows:

Fire Prevention: Fireproofing, electrical maintenance, cleanliness, watchman patrols, correct blasting.

Fire Safety: Fire alarm, escape-ways, refuge chambers.

Fire Fighting: Ventilation control, fire extinguishers, water supply and systems, equipment, equipment stations.

Fire Organization: Emergecy organization, predetermined methods, fire-fighting crews, trained helmet men.

In the so-called shaft mines the shaft is generally the heart of the transportation system. Extensive repairs in a shaft usually tie up production. Furthermore, the shaft is usually used for the passage of air for ventilation purposes. A fire in a shaft is therefore not only extremely dangerous but may prove costly from the standpoint of suspended production.

Only one kind of shaft is positively safe—namely, a "fresh-air" fireproof shaft, without inflammable materials in the shaft, on the station, or at the fresh-air source. Shafts of this type are becoming more common as time goes on. Control of ventilation at such a shaft is as important as the fireproofing. Nothing would be gained if gases from a fire in another part of the mine could drift to the fireproofed shaft, where men seeking safety would be overcome by these gases.

Shaft fires have been caused by electricity; by machinery, such as pumps; by cigarettes falling on wall plates; and by open lights used by repair men. Mines with shafts which cannot be concreted, because of ground movement or the lack of financial means, should install an effective sprinkling system and exercise great care in making electrical installations and in providing safeguards.

Relative to electrical installations made underground, positively no reason exists why this work should not be of the same high standard as that demanded by the building codes for surface structures. To provide less is to invite trouble. The fact that building codes do not extend to mines is no reason why the electrical work underground should be of a lower standard than that in the buildings above. One mine management in Colorado insists that electric wiring in timbered areas must either be sheathed in conduit or be lead covered.

Cleanliness and the regular disposal of rubbish are not only vital to the health of the mine workers but, if neglected, become a sure source of operating difficulties. To prevent mine fires, an absolute necessity is to demand a clean mine of the foremen; and a thorough inspection of the entire mine

Portable fan mounted on a truck and equipped with water spray ring

Cellar nozzle in action

A helmet crew ready for action

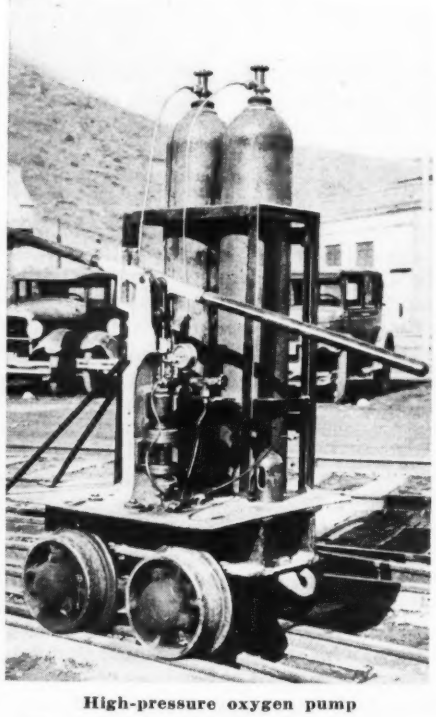
Man at the right is wearing a half-hour McCaa; the other five are wearing two-hour Gibbs oxygen-breathing apparatus

should be made at intervals not to exceed three months. Such inspection should be directed towards: oil-soaked platforms of various kinds; electric wiring that has become a hazard because of moving or squeezing ground; timbered areas littered with chips of wood left by repair men; rubber and cotton insulation material scraped from wires in making an electrical installation and left lying about; oily waste lying near small fans or stope hoists, and, worst of all, accumulations or rubbish, including lunch bags, refuse, used carbide, old powder boxes, and paraffined paper. Such accumulations are not only definite fire hazards but also create unhealthful conditions. Watchmen are used to patrol a number of large mines. In others shift bosses travel the mine after blasting.

I am of the opinion that blasting can be the cause of a fire in a metal mine just as surely as it has been the cause of fires in coal mines. Timber should be blasted with electric detonators, and, if possible, permissible explosives should be used for this purpose. When blasting in timbered stopes or near timber, good practice would include cleaning up all small pieces of wood or bark that may be lying around, and wetting down the entire place well before blasting. Tamping helps to prevent blown-out shots and the resultant long, hot flame.

Fire safety applies solely to the safety of men in the mine at the time of a fire. Mines equipped with general lighting on the levels can employ the circuit to flash a predetermined warning signal throughout the mine. Men on the levels who see the flash must spread the alarm to those in stopes and other places where no electric lights exist. Introduction of a volatile liquid in the compressed air lines, known as the stench system of alarm, is a positive method, and one that is used by a number of mines. The mine should be well marked with signs and arrows pointing to the escape-way. One important factor which should be taken into consideration when hoisting men out of a mine on fire is that a definite plan should be prepared in advance so that the men may be moved without delay. The shaft will be needed to transport fire fighters, and, if these men are delayed because of a disorganized attempt to get the miners out, the chances of holding the fire in check are small indeed, while the risk for the fire fighters is constantly increasing.

Refuge chambers have been advocated by the U. S. Bureau of Mines for some years. Many mines establish refuge chambers in dead ends of drifts by installing a mine door in such a drift as far out from the end as possible. The compressed air and water pipes are carried into these chambers. A flow of compressed air within the chamber keeps gases out. Many lives have been saved by barricades. The refuge chamber is, in fact, a preconstructed barricade.



High-pressure oxygen pump

The horizontal bars behind the oxygen tanks are removable, making the exchange of tanks easy

Perhaps nothing is so important during a mine fire as ventilation control. The terror, and to a large extent the hazard, of mine fires can be largely eliminated by effective ventilation control. In addition, far more effective work can be done toward fire extinction when fresh air is close behind the fighters, and when the smoke can be directed away without endangering lives in any particular part of the mine. Too much emphasis cannot be placed upon ventilation control. In most instances, it is the determining factor as to who shall be victor—man or fire.

Fire extinguishers are listed next because many small fires could have been put out had some handy means for smothering the flames been instantly available. Carbon tetrachloride extinguishers are non-conductors of electricity and should be used on electric fires. However, their general use underground in larger than quart containers may under certain circumstances be ill-advised. In close and poorly ventilated places men may be overcome by the gas generated from the liquid. Soda or foam extinguishers are therefore considered safer. One large mine is equipped with quart tetrachloride and with 2-gal. foam extinguishers. Both have been used to good advantage many times. Automatic sprinklers are also classed under this heading. I am strongly of the opinion that automatic sprinklers in a mine would render as valuable a service in the event of fire as such installations have rendered in warehouses, stores, and factories. One large Western copper mine has installed these sprinklers in all of the greatest fire hazard sections, and is seriously considering protecting the entire mine with them.

An adequate water supply and a well-laid-out system of water lines are of utmost importance, particularly during the early stages of a fire. All too often the underground pipework is left to the mine pipe fitter, who does the work according to his own ideas, with the result that a level is covered with a perfect maze of pipes and valves. In an emergency no one knows just how to get water. Some mines have an independent system for fire purposes; many employ a cross-over into the compressed air line. These connections are usually located near the shaft. In this manner a greater water capacity is provided.

Introduction of slimes or sand on top of a fire area is very effective—far more so than water. Water frequently cuts channels in the waste fill and follows them, the water thus being wasted. When sand and slime are introduced with the water, they tend to build up a delta and spread over large areas. Thus not only is a seal built above the fire

by the solid material, but, also, the water spreads out over a fan-shaped area reaching all parts of the fire district.

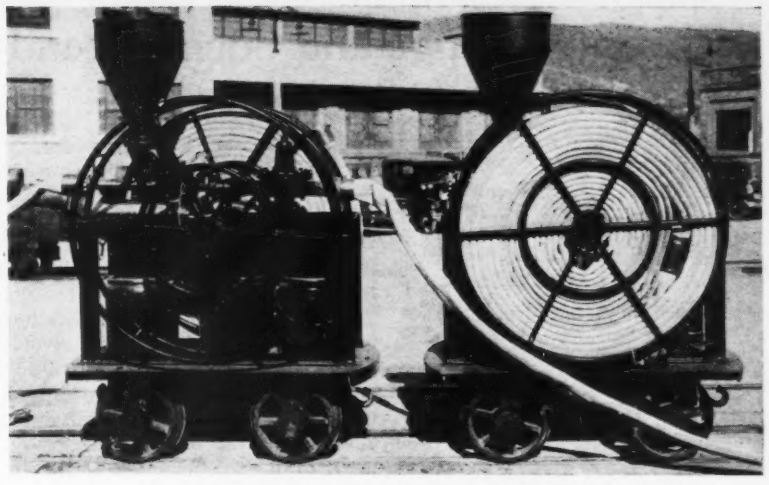
Fire-fighting equipment should, of course, be ample. Fire hose of sufficient strength and in sufficient quantity is necessary. Made-up manifolds that can be connected to the main water line, to which a number of hose lines can then be connected, are handy and save time. Revolving cellar nozzles are good for fires in raises and chutes. They can also be connected to pipes, and then pushed into a blazing area with effective results. As many lengths of pipe can be screwed together as necessary or as conditions permit. I have used a cellar nozzle successfully at the end of 30 ft. of 1-in. pipe. To have directed water in as many directions and over as great an area in any other way would have been impossible.

Portable auxiliary fans are essential where smoke must be penetrated. These should preferably be mounted on a truck. A water-spray ring attached to the fan will assist in killing gases, and will improve heat conditions tremendously for the fire fighters ahead. Brattice cloth is a valuable material in a fire. I know of one mine fire in which brattice cloth was an important factor in maintaining production. A drift was divided with it; on one side hot gases from the fire were directed to the surface outlet, and the other side, kept under fresh-air pressure, served as a passage to ore passes that had to be kept in use if production was to continue uninterrupted.

Fire tool trucks are necessary. These trucks, at all times fully equipped and locked, should be kept in a dry place. They should contain: hammers, saws, nails and spikes, brattice cloth, pipe fittings, unions, bushings, spuds, nipples, wrenches of various kinds, a 1,000-ft. life line, and several long electric-light extension cords. A portable telephone, with a 1,000-ft. reel of wire, has served me and my associates particularly well in mine fires. An electric signal life line, mounted on a truck, is also advisable, if extensive exploration by helmet men must be undertaken.

Whether or not oxygen breathing apparatus and gas masks shall be owned by a mining company depends largely upon the mine, the known fire hazard in it, and the proximity to a large mining district where such apparatus and masks are available. A mine that must give attention to fire hazards should be equipped with oxygen breathing apparatus and gas masks. This equipment must be kept in perfect condition, and the men who will be called upon to use it in an emergency must be in training. Gas masks give excellent service, but are safe only when their limitations are recognized. A candle or a coal miner's safety lamp should be included in the equipment of each mask crew.

Preparedness is half the battle in fire fighting. A mine not organized for such an emergency is likely to meet with defeat. On more than one occasion death has stalked among those willing workers whose efforts were misdirected because of lack of advanced planning. A complete personnel organization should be worked out and kept up to date. Each individual should know his function during an emergency. Helmet men should be well trained in the type of work that may be demanded of them. If all of them cannot be trained in the courses offered by the U. S. Bureau of Mines in mine rescue and recovery work, at least the crew leaders should receive this advanced training.



Portable Foamite generator equipment

These home-made trucks are designed to carry 200 ft. of 2½-in. hose, the Foamite generator, and three to four large cans of powder. When the funnel is taken down and placed horizontally on the upper shelf of the truck, the equipment will pass through a 4x6-ft. drift. Fittings necessary to attached hose to pipe are also carried

Methods of attack should we worked out in advance for every district underground in which a fire might occur. The things one does not know about the mine which are brought to light by such a study are surprising. Direction of air currents, how to change them, what to do with the smoke, where to connect hose, whether to attack from above or below—these are some of the absorbing questions that must be answered. I realize that mine fires cannot be fought by predesigned rules of thumb. However, such a study, if followed through, will, above all, give confidence where a panicky mind would otherwise exist. The individual caught by surprise is always at a disadvantage; therefore, any plan is better than none.

One more word may be added, and that is: Have an ample number of men available for all that is to be done, and not one man more. A certain amount of confusion always prevails during a fire, particularly in its early stages. To have more men on hand than can be kept busy is to add to this confusion, and reverses at the front are much more likely to cause a panic than they would with a well-organized and well-directed busy crew.

This article could be continued at length. Little, however, would be gained in going into greater detail, particularly as each mine presents an individual problem, and methods therefore must vary accordingly. The U. S. Bureau of Mines has studied many mine fires and has made the knowledge gained available in numerous publications. The American Mining Congress, through a committee headed by W. V. DeCamp, has published a comprehensive and detailed standardized schedule for the prevention and fighting of mine fires. These works are recommended to those interested in the subject. An outstanding feature of all that has been written on mine fires is the imperative necessity of preparedness in prevention, equipment, and organization.

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Technical Change and Social Trend

RECENT SOCIAL TRENDS IN THE UNITED STATES. *Report of the President's Research Committee. New York: McGraw-Hill Book Company. Two volumes; pp. 1,568; $10.*

In 1929, during the prosperity era, after issuance of a report on "Recent Economic Changes" that boasted of enviable economic momentum and forecast continuance of favorable material conditions, President Hoover appointed a committee to study social trends. The two tomes under review represent a summary of the contents of thirteen volumes, yet to appear, containing the factual findings of the authors, almost all of whom are college professors.

Engineering and Mining Journal hesitated to join in the general chorus of congratulation that greeted the appearance of the report on "Recent Economic Changes," maintaining that a less boastful attitude would have been more becoming. The latest report in a series that commenced with a study recommending the elimination of waste by the manufacturer—at a time when the consumer was being coaxed and harangued to disdain frugality—calls for no similar criticism, although one wonders what conclusions on social trends might have been reached if the more recent survey had been made instead during the period of high living, when political and industrial leaders encouraged individual and group indebtedness to an extent that now constitutes a serious impediment to economic recovery.

In a preface to the report under review, President Hoover contends that "Since the task assigned to the committee was to enquire into changing trends, the result is emphasis on elements of instability rather than stability in our social structure." This reasoning infers, apparently, that change connotes disequilibrium; and in this reasoning may perhaps be found explanation for the exasperating dilatoriness shown by government in coping with the problems resulting from a fundamental dislocation of social and business relations —the outcome of unparalleled technical advance and unlimited credit—clearly apparent to ordinary mortals since the turn of the tide of so-called prosperity.

The twenty-five monographs presented in "Social Trends" discuss almost every phase of respectable human activity. A contribution on mineral resources, by F. G. Tryon and M. H. Schoenfeld, of the Brookings Institution, emphasizes the limitations of reserves; and the authors consider that "the problem of the conservation of the minerals is not absolute exhaustion at some distant date but rather increasing cost in the near future through the growing difficulty of mining." Coal is evidently under major consideration, but large-scale operations have permitted introduction of new and improved techniques in other branches of activity. "In metal mining," the experts report, "the advances have been revolutionary. Shaking tables of the Wilfley type permit the sorting of fine material by gravity. The ingenious process of flotation has made possible the separation of valuable material from refuse with uncanny precision and completeness"—illustrating one feature of the survey—what a critic has described as the "quantitative statement of the obvious." Conclusions in respect to mineral economics are influenced by the de Launay thesis—that activity starts with gold, and continues with other metals in order of unit price. Gold mining, therefore, according to these authorities, has passed its zenith—a conclusion not wholly in accord with recent statistics. Accepting the de Launey scale, however, one is told that the United States is in the copper state of mineral exploitation; that it "continues to be the largest exporter of copper in the world," but that "imports of ore and crude material have been growing faster still."

The authors announce that the copper interests in the United States are "demanding" a tariff, whereas protection on copper, amounting to 4c. per pound, has been in effect since June, 1932; so in this detail the survey succeeds in reflecting neither recent trends nor current events. The monograph is concluded by a reminder that the long-time problem of conservation merges with the immediate social problem of overdevelopment and overproduction. Both are concerned, one is told, with control of the waste of destructive competition. "The task of the present-day conservationist is to see that any change in economic organization for the control of production . . . should also operate to prevent needless waste of resources."

The major significance of the report, however, lies in the conclusions and recommendations to be found in a "Review of Findings" that forms an introduction to Volume I. "The committee does not wish to assume an attitude of alarmist irresponsibility," one reads, "but it would be highly negligent to gloss over the stark and bitter realities of the social situation, and to ignore the imminent perils in the further advance of our heavy technical machinery over crumbling roads and shaking bridges." The metaphor may be mixed, but the significance of the warning is unmistakable; and the extent of the change in attitude of academic experts in less than four years is emphasized when the statement is compared with extracts from the report of 1929 on "Recent Economic Changes," a few of which follow: "The acceleration of forces and its resultant rising standard of living have been facilitated by a continuing supply of funds. . . . We have communciation to speed and spread the influence of ideas. . . . We have a great national opportunity. . . . The degree of progress in recent years inspires us with high hopes. . . . Our nation is accustomed to rapid movement, to quick shifts in status; it is receptive to new ideas, ingenious in devices, adaptable. . . . Our situation is fortunate; our momentum is remarkable."

Although the full extent of radical deviation in trend was reported when "Recent Economic Changes" was written, no consideration was paid to the elements of instability that eventually undermined the economic foundation. Now that the bad effects of unlimited borrowings and expansions of credit, of the spread of ideas characteristic of a period of unhealthy economic growth, are recognized, a change in general sentiment is apparent, although the committee sees no prospect of alleviation in conditions by a return of any section of society to a simpler mode of living, inferring that a move toward independence from a highly strung mechanical civilization involves a lowered standard of living—the reference presumably being solely to physical standards. Attention is urged to the need that social discovery keep pace with mechanical invention, to which recommendation general agreement may be expected. Perhaps with a remembrance of the direction in which politics and business have molded the spending habits of the people of the United States in the last decade, no call is made for leadership. The respite is welcome, and the hope is here expressed that a change may occur that will permit the individual to escape the perpetual barrage of propaganda that hinders him from planning a personal future of adequate security and thrifty purpose, and thus contributing his share to economic and social stability.

Emergence from the present "predicament," the investigators maintain, is only possible by utilizing the intelligence of the nation as a whole; they insist that a prerequisite must be a "willingness and determination to undertake important integral changes in the reorganization of social life, including the economic and political orders, rather than pursuance of a policy of drift."

The drifting process, so much in evidence since 1929, is no new development, however. Its supporters resist reform now with no more determination than was exhibited in boom times. They seem determined that government and management shall not be taken from the hands of tried and experienced politicians; and the chance is small that individual intelligence be permitted to form group opinion that will influence a change in fundamental social conditions. Published suggestion that in the people lies the remedy serves as a con-

venient soporific, as an anodyne to counteract the pronouncements of those who are fearful of the eventual results of complacency and self-satisfaction.

Whatever happens, posterity, by making a psychological and analytic study of the boom report on "Recent Economic Changes" and the companion depression report on "Recent Social Trends," will be in a position to determine the cause and to measure the effect of realignment in the United States during two successive periods characterized by (1) intense commercial activity and credit expansion and indebtedness, and (2) an awakening public consciousness of fundamental economic instability. A. W. ALLEN.

DEEP BOREHOLE SURVEYS AND PROBLEMS. *By M. H. Haddock. 296 pp., illus. New York: McGraw-Hill Book Company; $4.*

Professor Haddock in this treatise essays to give the various reasons for deviation of deep boreholes, especially vertical ones, and to describe methods of surveying them. Besides drawing from his own experience, he has used that of many others from different parts of the world, especially oil-field engineers from the United States and from Rumania. He has also so profusely illustrated his book with photographs and sketches of the numerous instruments and methods of surveying boreholes that even the most intricate detail can be clearly understood.

The book might well be divided into three parts, the first on deviation and its causes, and auxiliary registrations in borehole surveys, including causes of deviation in deep boreholes, with descriptions and illustrations of many actual surveys from various parts of the world. Various recording instruments used while drilling the hole include instruments for showing drilling progress, depth measurements, pressure records for various parts of the hole, and thermal records. Construction of plans and sections along the borehole is also clearly explained. Borehole models are then taken up in detail in the second chapter, several different ones being illustrated.

The second part of the book includes the chapters on instrumental survey of boreholes, divided into a general chapter on surveying methods, a chapter on core orientation, and six chapters on the actual survey of the hole for bearing and inclination. The general chapter gives the requirements for an ideal surveying device, then briefly describes the various known surveying methods. The latter are separated into two classes—those for orientating the core to show strike and dip of strata, and those for actually surveying the hole. Purposes of boreholes are also described in this general chapter. The chapter on orientation gives several methods for obtaining dip and strike of the strata, instruments used for this purpose being illustrated and described. The six chapters on borehole surveying are on fluid methods, compass and plumb-bob methods, pendulum methods, photographic methods, gyroscopic compass methods, and geophysical methods. Each chapter gives all the well-known surveying instruments under that particular method, from the oldest to the most modern, with their good and bad points. Here again we find each instrument clearly illustrated and described.

The third part of the book includes the chapter on the various problems that might be encountered in prospecting with boreholes, as well as the bibliography.

Professor Haddock has gathered together in this one volume all the principal facts on the surveying of deep boreholes hitherto confined to the technical magazines and society transactions. Geologists and mining engineers who are associated in any way with deep drilling should have this work on their book shelves as a reference.

W. REX STORMS.

GRUNDZÜGE DER PHYSIKALISCHEN VERHÄLTNISSE DER FESTEN ERDE. *Erster Teil.* (Fundamentals of the Physical Relations of the Solid Earth. Part I.) *By E. Tams, Berlin: Gebrüder Borntraeger. Pp. 184; illus.; Rm. 14.*

This volume is one of the series on the geology of the earth being prepared under the editorship of Prof. Erich Krenkel, of Leipzig. It discusses (1) the size and shape of the earth and the horizontal and vertical distribution of its surface features; (2) the constitution of the earth as a whole; (3) the constitution of the outer portion of the earth; (4) thermal relations of the earth and its age; (5) gravity distribution upon the earth and the mass arrangement of its outer part.

The author makes clear in his preface that the book is neither a textbook nor a handbook of geophysics, but departs from such treatises as have appeared, in that the results of geophysical studies are taken for granted, and the attention is directed particularly to the geological significance of these results. Granting this limitation, the volume is a good compendium of geophysical results as applied to the broader earth problems.

Seemingly the sequence of the chapters is not always logical. It is not clear why the shape of the earth should have been treated in the first chapter and gravity postponed until the last when the results of the former are to a great extent dependent on those of the latter.

The book contains much useful information, although if one wishes to know most of the derivations one will have to go to original sources, regarding which copious references are given, or else to the textbooks and handbooks of geophysics. M. KING HUBBERT.

DESCRIPTIVE PETROGRAPHY OF THE IGNEOUS ROCKS. VOL. II: The Quartz-bearing Rocks. *By Albert Johannsen, Pp. 428; Illus. Chicago: University of Chicago Press; $5.50. London: Cambridge University Press.*

This volume is devoted wholly to the over-saturated rocks. Described in great detail are nine "families" of quartz-bearing rocks, ranging from highly siliceous rocks such as greisen and beresite, included in Family 0, to moderately siliceous rocks such as quartz-diabase and quartz-gabbro, included in Family 8.

Professor Johannsen uses his own system of classification, explained in Vol. I, previously published, which may be confusing to the student who has not been brought up on it, but which is relatively simple and quite logical, although the nomenclature is somewhat awkward and cumbersome for common use. Such terms, for example, as "leuco-calciclase-syeno-gabbro" and "leucogranodiorite-aplite" may give a good mental picture of the aspects and make-up of these rocks to a petrographer, but they are not convenient for ordinary use.

Certain features of the book are excellent and much to be commended. Among these are a carefully detailed description of the megascopic and microscopic features of the various rock types; descriptions of every essential and accessory mineral component reported as occurring in rocks of the chief rock families; chemical analyses of many of the rocks described, together with tables of the modes—a convenient and important feature of this book—; and definitions of and the history of the rock names used.

A vast fund of information is provided in this volume for the student of igneous rocks, and the author is to be congratulated for the careful, painstaking labor which must have been necessary in the compilation and assembling of all the data contained in it. Numerous photomicrographs illustrate different types of rocks; but, unfortunately, the reproductions of many of them are not good, and they are consequently not convincing.

The student who may have occasion to use this book must be polylingual; quotations in the original are freely used. The reviewer finds quotations from German, Italian, Swedish, Latin, and Greek publications, without accompanying translations. This may prove disconcerting to the average student, who is not conversant with these languages.

This volume, together with Vol. I, previously published, and Vol. III and Vol. IV, yet to appear, will form the most ambitious and comprehensive work on descriptive petrography in the English language. No geologist whose specialty is in the field of petrography can afford to be without this work.

R. J. COLONY.

Among Contributors To This Issue

Oscar A. Glaeser (University of Washington, 1923) began his professional career in Alaska, with Kennecott Copper, Gold Bullion Mining, and the Alaska Engineering Commission. In 1922 he joined the staff of Pacific Coast Coal, as ventilation engineer and, later, fire boss. Connection at Jerome, Ariz., with United Verde Copper followed in 1924, where Mr. Glaeser started as a miner and later became safety and ventilation engineer, the position now held. Mr. Glaeser has specialized on mine ventilation and is a recognized authority on the subject.

Dr. Harrison Schmitt (University of Minnesota, 1921; Ph.D., 1926) served as assistant geologist to Standard Oil of Indiana prior to appointment in 1923 as engineer and regional geologist in Chihuahua, Mexico, for A. S. & R. In 1927 he was appointed chief geologist, with headquarters at Hanover, N. M., for New Jersey Zinc. In 1931 he established an office as consulting engineer in El Paso, Tex., specializing in the application of geology to mining.

W. Rex Storms was graduated in 1923 from the College of Mines, University of Washington, and joined the underground force of United Verde Copper, at Jerome, Ariz. In 1926 he was appointed geologist to the company, in which capacity he has acted to date, except for a year during which, on leave of absence, he acted as mining engineer on the staff of an exploration company in South America, in charge of diamond-drill hole sampling. The article on "Sampling Diamond-Drill Holes," on another page, as well as two other articles on other phases of diamond-drilling practice scheduled to appear in subsequent issues, have been abstracted from a thesis submitted to the University of Washington, and on the acceptance of which the degree of Engineer of Mines was granted to Mr. Storms.

Lucien Eaton was for fifteen years on the staff of the Cleveland-Cliffs Iron Company, mostly as superintendent of the Cliffs Shaft mine. He later became consulting engineer on the staff of Rhodesian Selection Trust, with headquarters in London. Since his return to the United States last year he has spent much time on the Marquette Range, in Michigan, and now has his headquarters at Milton, Mass.

W. E. Sinclair, born and educated in South Africa, served as mining engineer to Witwatersrand Deep, Ltd., Johannesburg, Transvaal, from 1912 to 1917, when he was appointed mining engineer on the staff of Union Minière du Haut-Katanga, Belgian Congo, a position held until 1925. Subsequently he served as mine captain for Ashanti Goldfields Corporation, Ltd., operating on the Gold Coast, and as mine manager for the Anglo-Nigerian Tin Mines and Niger Rayfield Steam Shovels companies, operating in the region in Western Africa about which he writes elsewhere in this issue.

Frank Ayer has been appointed general manager of Roan Antelope Copper, Northern Rhodesia, vice **David D. Irwin,** resigned. Mr. Ayer, a graduate of the Columbia School of Mines, has been associated with mining in Arizona since 1912, when he became associated with Detroit Copper. He served as mine foreman with Inspiration Consolidated and Burro Mountain Copper, then as assistant mine superintendent of Moctezuma Copper, mine superintendent and, later, general superintendent. He became manager of the Morenci Branch of Phelps Dodge in 1927, a position from which he recently resigned to accept the Roan Antelope appointment.

A. R. Andrew, of Dunedin, New Zealand; **E. R. Davis,** of Sussex, England; and **G. K. Kenneth,** of Port Pirie, South Australia, were recently elected members of the Institution of Mining & Metallurgy.

W. A. Leddell, specialist in the metallurgy of gold and silver ores, particularly by application of the cyanide process, has established an office at 511 Fifth Ave., New York City.

Walter J. Eaton has resigned as mine superintendent for Patiño Mines & Enterprises, operating at Llallagua, Bolivia, and is returning to San Juan Capistrano, California.

H. B. Schell, formerly manager of the Mount Bischoff Extended, has been appointed assistant manager of the Aberfoyle tin and wolfram property in Tasmania.

Nels E. Nilson has returned to Australia after a visit to L'Anse, Mich.

J. A. McLaughlin has succeeded **William Sharp** as superintendent of the Weepah-Horton mine at Weepah, Nev.

J. Kruttschnitt, general manager of Mount Isa Mines, Queensland, has been elected a member of council of the Australasian Institute of Mining and Metallurgy.

R. Barthelemy has resigned from the position he has held for the past two years in charge of concentration research in the Belgian Congo for Union Minière. He expects to return to France in February.

John F. Spedding, formerly with Oliver Iron Mining at Ely, Minn., and later engaged in mining work in the Central Provinces of India, has been appointed manager of the Long Rake Spar mine at Youlgrave, Derbyshire, England.

M. A. Grandy recently returned to White Cliffs, Ark., after an extended visit to the properties of Marianna Lime Products, Florida Lime Products, and Arkansas Lime Products in Florida, on the staff of each of which companies Mr. Grandy is general superintendent.

Prof. Charles H. Behre, of Northwestern University, Evanston, Ill., is a member of the executive committee of the newly formed Geological Society of Chicago. Other members comprise **Edson S. Bastin, John R. Van Pelt, Theron Wasson.**

C. Price-Green, formerly commissioner of natural resources for Canadian National Railways, has been appointed a director of Arcadia Gold Mines, operating in the Porcupine district of northern Ontario.

Thomas Gray, superintendent of operations of Tharsus Sulphur & Copper, Huelva, Spain, and **N. P. Rutherford,** of London, England, recently visited Butte, Mont.

F. A. Brinker has resigned from the Ruth Company and is now operating a flotation testing laboratory in the Continental Oil Building, Denver.

Charles A. Mitke recently concluded an examination of the mines in Arizona, and is now on similar professional work in Mexico.

Sir Douglas Mawson, professor of geology at the University of Adelaide, and noted Antarctic explorer, is in England.

Association of 27th Engineers, U. S. A.

The Editor:

The accounts of what subsequently became the Association of the 27th Engineers go back to Feb. 6, 1918, when the Comfort Fund was instituted under the auspices of *Engineering and Mining Journal*. With the end of 1932 the accounts were closed with the donation to the American Red Cross of the residue of $40. The receipts and disbursements for the whole period have been as shown in the accompanying statement. All executive services and the major part of the clerical have been gratuitous from beginning to end.

Association of 27th Engineers, Receipts and Disbursements, Feb. 6, 1918, to Dec. 31, 1932

Receipts

Contributions	$20,262.90
Dues	605.90
Sales of wool	651.28
Interest	705.39
Repayment of loans	175.00
Sale of history	116.58
Total	$22,517.05

Disbursements

Athletic goods	$2,054.68
Musical instruments and music	2,809.84
Cigarettes and tobacco	2,165.97
Games	95.75
Typewriters	341.50
Wool and garments	1,834.82
Assistance and loans	4,838.34
Contributions to company funds	1,501.62
Christmas celebration, 1918	2,500.00
Bank exchange	18.53
Stationery and printing	92.90
Medal	603.73
History	1,351.43
Postage and telegrams	221.69
Clerical and other services	91.05
Christmas letters	802.68
Reunion and colors ceremony	718.43
Gift to Louvain memorial carillon	300.00
Miscellaneous	134.09
Total	$22,517.05

When the regiment went oversea it was provided with the musical instruments for a 32-piece band, which engineering regiments at that time did not regularly have. Each company was provided with an athletic equipment. The men were kept supplied with cigarettes and tobacco. Typewriters were furnished to such of the officers that needed them in the performance of their duties. Wool was purchased and was furnished to a large group of women within the A.I.M.E., who knit socks and sweaters, which were forwarded to the regiment. Contributions were made to the company funds out of which expenditures occurred in their own ways. A Christmas dinner and regimental celebration were provided at Christmastide, 1918.

Upon the demobilization of the regiment in the spring of 1919, the executive committee decided to employ the remainder of the funds for the striking of a regimental medal, for the publication of a regimental history, and for pecuniary assistance to ex-members of the regiment who found themselves in need, the understanding being that such advances were to be refunded if possible, but not to be obligatory. It was also decided to reserve sufficient money to pay the cost of a Christmas letter signed by the Colonel and the President for a series of years. This has been issued every year up to, and including, 1932.

After a good deal of trouble and the unraveling of a tangle of red tape, the regimental colors were recovered in 1924 and were turned over to the United Engineering Society, as custodian, and by it were placed in an appropriate case in the entrance hall of the Engineering Societies Building in New York. This transfer was made the occasion of an impressive ceremony and of a regimental reunion which was authorized by the executive committee.

Subsequently, with the authorization of the executive committee, a gift was made for the Louvain memorial carillon, known as the War Memorial to American Engineers.

Under the head of miscellaneous is included such things as freight and express charges. All other expenditures are self-explanatory.

Under the head of receipts there are some items that require explanation. At the outset the members of the regiment who had formed themselves into an association while they were in France desired to pay dues. The receipts under that head occurred in that way. This idea was soon discarded, however, as being impracticable. In respect of wool we purchased large quantities and resold some at cost to other organizations. Every member of the regiment was presented with a copy of the regimental history. A price of $1 was put upon this volume and there were sales to members of the regiment who wanted extra copies and to outsiders.

At the time of the return of the regiment from France, March 20, 1919, the roster comprised the names of about 1,600 officers and privates. Since that time the roster has been kept in the office of the association and has been constantly revised. For the issue of the Christmas letter of 1932 it comprised 575 names. The shrinkage is partly due to death, but mainly through loss of addresses.

W. R. INGALLS,
President and treasurer,
Association of the 27th Engineers.
New York, N. Y.

W. P. Alderson and **A. A. McMartin**, of Montreal, have sailed for Africa, to examine properties in the Kakamega gold field, in Kenya, for Canadian interests. **Sir Albert Kitson's** recent report on the area might be read to describe the gold-bearing areas of northern Canada, except that the older rocks are more prevalent than in the Canadian Precambrian. Placer mining has been most prominent up to the present, but attention is now beginning to center on the lode deposits that have yielded the gold, which are of more interest to Canadian gold miners.

G. S. Brooks, president of the Giesche Polish group, has been elected to the foreign seat of the Presidium of the central organization of Polish industry at Warsaw, established last year to join in economic council with the government on the industrial problems of the Republic of Poland.

Herbert W. Gepp, prominently identified with the development of flotation processes at Broken Hill, New South Wales, has been honored by King George with a knighthood.

Enoch Perkins is in New York.

N. A. Timmins is in South America and expects to travel there for several months.

K. S. Twitchell is again in Arabia, on professional work. He expects to return to New York in April.

William Whyte has resigned as mine superintendent to Wiluna Gold, and has left Western Australia for England.

George K. Williams is leaving Montana shortly to join the staff of Cyprus Mines Corporation, operating at Skouriotissa, Nicosia, Cyprus.

Arthur Swanson, formerly consulting engineer to the U.S.S.R., is now manager of Los Lugos Gold Mines, Mesquital del Oro, Zac., Mexico.

Robert W. Karpinski recently returned to Ann Arbor, Mich., from Alaska, where he made an extensive mining reconnaissance for a Detroit syndicate.

Stewart Campbell, for many years inspector of mines for the State of Idaho, is now in practice as a consulting engineer, with headquarters at 104 Bannock St., Boise, Idaho.

A. F. Brigham, consulting engineer for Hollinger Consolidated, has organized a campaign of exploration for new mines, and is spending most of his time in the field — from northern Manitoba to northeastern Quebec, throughout which wide area the company has several promising operations.

■

Obituary

Frederick W. Callaway, prominent litigation engineer, at Spokane, Wash., on Jan. 6; aged 52. Mr. Callaway was associated for many years with the Bunker Hill & Sullivan company.

E. H. Kellogg, specialist in safety practices and member of the staff of Mine Safety Appliances Company, formerly associated in research with the Department of Agriculture and Bureau of Standards; at Pittsburgh on Jan. 9; aged 40.

H. A. Clark, assistant sales manager, McGraw-Hill Publishing Company; on Jan. 28 near Woodbridge, N. J., from an automobile accident; aged 39. Mr. Clark, formerly an athlete of prominence, was at one time on the advertising staff of *Engineering and Mining Journal*.

Ira F. Taylor, superintendent of the Boriana mine, Yucca, Ariz.; at Whittier, Calif., on Dec. 31, 1932; aged 54. Mr. Taylor, whose grandfather was one of the "forty-niners," was born at Deming, N. M., and gained wide experience in mining in British Columbia, Mexico, and the southwestern United States.

Guy H. Buchanan, chief technologist, American Cyanamid Company; inventor, specialist in the mechanism of selective flotation and in the development of flotation reagents; at New York on Jan. 21; aged 44. Mr. Buchanan, who was graduated from Washington and Jefferson College, was for a time on the faculty of M.I.T., on the research staff of New Jersey Zinc, and with Air Nitrates Corporation.

INDUSTRIAL PROGRESS

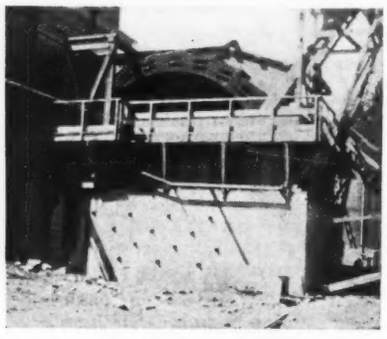
Operating Results Obtained With Hadsel Mill Indicate Economical Reduction

Harlowe Hardinge
Vice-president and general manager
Hardinge Company, Incorporated, York, Pa.

IN DISCUSSING the new departure in the technique of ore reduction represented in the Hadsel mill, I do not wish to convey the idea that the method described is fundamentally new, although the results secured are radical, as is the design of the machine. The new method still uses the "drop" principle, wherein a large heavy body falls on a small body to reduce the latter to the desired size. Stamps and ball mills also use this principle. The only real difference lies in the way the forces are exerted. That difference, however, is much greater than one might think if no analysis were made of the action resulting and the energy exerted in comparison with that required to give the same result in the so-called standard practice.

In common with so many new combinations of old ideas, the Hadsel mill was developed by one who was not a so-called expert in crushing and grinding theory. The present design was reached through evolution. A. D. Hadsel, the inventor, is a mechanical engineer, and for years has devoted time to material handling in one form or another. Recognizing the inherent inefficiency of crushing and grinding equipment as used, he undertook to study various principles involving the crushing and grinding of materials by utilizing the force of impact of materials on themselves without other grinding media. None of the methods he tried at first gave satisfactory results as to fine grinding.

Mr. Hadsel developed the predecessor of the present mill for use at a low-grade gold mine, in California, where the only chance of making the mine pay seemed to lie in cutting the milling costs well below the accepted standard. This mill had a 16-ft. wheel and was crudely built. Basically, the original mill was like that of the present design. The wheel had a series of buckets which raised the ore to maximum elevation and then let it fall on breaker plates near the bottom. The larger pieces were chipped or broken in hitting the plates. On the latter remained a layer of large and small pieces which were further ground by the oncoming torrent from subsequent bucket loads and pushed off into the tank. The coarse pieces sank, passed into the buckets, and were lifted again. The fines in suspension were removed from the immediate zone of the buckets by the circulating action of the water and allowed to overflow at the side.



Duplex Hadsel mill installed in a California plant

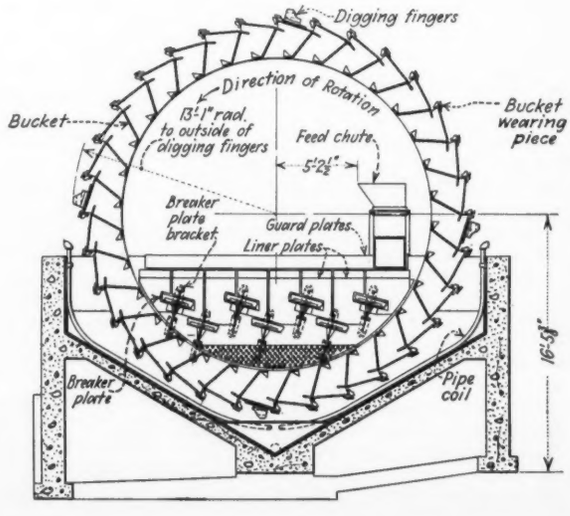
Any oversize which settled out on the outside of the wheel dropped to the bottom of the tank and was scooped up by lips on the edge of the wheel and re-deposited in the buckets for re-circulation and regrinding.

The 16-ft. mill did good work on friable ores, but failed to reduce tougher and harder ores in commercial quantity. The height of fall was insufficient, the bed of ore on the plates would build up and form a cushion, and the method of removing the fines from the tank was crude and not controllable within reasonable limits. Several months' operation taught the experimenters much about proper speed of rotation, shape of breaker plates, classifying action, potential capacity, and other factors. In the meantime, the ore dropped in grade so that mining ceased.

Among the visitors who saw the 16-ft. mill in operation was Alex Wise, who later installed it, in modified design, at his property near Georgetown, Calif. This mine was held to be limited in size, the ore values running approximately $4 over a 15-ft. width. However, over the full width, which was 40 to 50 ft., the values were $2 and $3 per ton. The ore was comparatively free-milling and the slimes were low in gold. By floating them off and leaching the sands by cyanide, reasonably good recoveries at low operating costs would be assured, provided the new Hadsel mill could reduce the run-of-mine ore to a finished product of about 65 mesh with 65 to 70 per cent through 200 mesh in the mill classifier overflow.

Results of these tests led to a decision to build a "duplex mill," having 24-ft. bucket wheels and an estimated capacity of 200 to 300 tons per day. Grinding tests were made with it in February, 1932.

The accompanying sketch shows the general features of the mill as now in service at the Beebe mine at Georgetown. As shown, it has two 24-ft. bucket wheels. In many features it differs from its predecessor. It allows a free drop of 16 ft. from the buckets to the breaker plates, as against 8 ft. for the other. A far greater shattering



Diagrammatic sketch of duplex Hadsel mill, shown in side view

and grinding effect results. The breaker plates are smooth but are set at a slight angle so that the ore does not build up into a mound. Only a thin layer remains on them at any one time. Sufficient remains to protect them from wear, and this is exposed to the crushing and grinding action of the oncoming material. Here is the apparent explanation of the unusually effective fine-grinding action.

The ore dropping off the plates falls through the water, as in the 16-ft. mill. The finished product and fine oversize flow out of the wheel above the bucket shroud and into the tank, and owing to the circulation and agitation produced by the motion of the wheel, the pulp moves around to the back and up through an adjustable opening and out of the mill altogether.

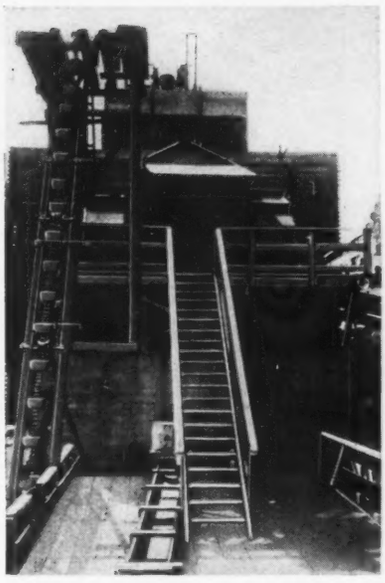
The adjustable outlet is the principal means of controlling fineness of product. By moving an adjustable baffle plate on the inner wall of the tank out toward the bucket wheel, the area of opening is increased, the velocity of discharge decreased, and a finer product secured. Conversely, by moving the baffle in, the velocity is increased and a coarser product obtained. Oversize dropping out at this point is picked up by the lips on the wheel's periphery, re-deposited in the bucket and again dropped on the plates.

An interesting feature of the mill is its ability to trap gold in the tank bottom. The shape of the latter is changed slightly if free gold is to be recovered periodically or continuously, so that the metal will concentrate readily in sumps near the center of the wheel, from which point it may be withdrawn, continuously or periodically, as desired.

An important feature is the fact that each time the ore is dropped and fines are produced, the latter are classified out before they can build up and form a cushion. This cushioning occurs in operating all ball tube mills and stamp mills, and reduces grinding efficiency.

Theoretically, the mill is still far from efficient, even though the results are superior to any secured in a mill treating the same ore in the Georgetown district. One can readily calculate that to grind 300 tons of ore per day, approximately 70,000 tons must be lifted and dropped. Calculation shows the theoretical horsepower to be only about two-thirds of the recorded horsepower.

The ore in dropping does not shatter into several pieces at once; at least, the harder ores, such as that from the Beebe mine, do not. Large and small pieces hit the breaker plates, apparently without being broken. Careful examination shows that small chips are usually broken away, or else, after several drops, the structure is so weakened that minute cracks form which eventually cause breakage. This chipping action reduces the large pieces. The small particles of oversize will not chip noticeably, as their mass is insufficient.



Another view of the California plant housing the new duplex mill

But the coarser particles dropping the full 16 ft. have an appreciable grinding effect on the small ones on the plates.

The manner in which the mill is working can be observed at all times, as one side is open. This facilitates inspection for possible wear, although this is nominal. The buckets have a lip which retards discharge so that the material will spread over the plates. This retarding action also prevents the ore from sliding in the bucket bottom, which reduces wear at this point.

The breaker plates are mounted on brackets, made very strong to withstand the impact caused by large boulders. At the Beebe mine pieces larger than 15 in. have occasionally got into the mill, and, although weighing 150 lb. or more and dropping the full height, have been so reduced in a few revolutions that their identity was lost.

R. G. Hall made exhaustive tests on this mill prior to the actual operation of the cyanide plant at the Beebe mine. In his report he says, in part:

Rate of feed was adjusted to maintain motor load at about 98 hp. and the final test was begun.

Character of ore: Mine run dump, unoxidized

Water per minute: 380 gal.

Pulp density: 11.66 per cent average

Horsepower: 98 hp. output

Efficiency of motor: 86 per cent

Power input: 114 hp.

Tonage of ore: 308 per 24 hr.

Power output per ton: 7.7 hp.-hr. per ton

Power input per ton: 6.7 kw.-hr. per ton

Grade of Product	Per Cent	Cumulative, Per Cent
On 60 mesh	3.00	3.00
On 80 mesh	9.00	12.00
On 100 mesh	4.20	16.20
On 150 mesh	8.40	24.60
On 200 mesh	10.20	34.80
Through 200 mesh	65.20	100.00

Results indicate great uniformity of operation.

Power consumption was notably low, considering that mine-run material was being fed. To attain the same fineness of final product would under conventional practice require a breaker about 15x24 in. in size, a 30-hp. motor, a cone crusher or its equivalent with a 50-hp. motor, and a ball mill having a 150-200-hp. motor. All would not be working at full-load capacity, but the installation costs and power bills for 300 tons' daily output might well approach three times the 100-hp. installation of the Hadsel mill.

Where operations are on a large scale, with wide stopes, a breaker will probably be required to give pieces that will pass a 12-in. grizzly. The mill will handle much larger material successfully, but the dropping of pieces exceeding 200 lb. in weight from a 16-ft. height would seemingly necessitate heavier construction of the breaker plate supports than is desirable.

Water consumption for the ore in question seems satisfactory at about 1,500 gal. per ton output. This is sufficient to produce proper grinding conditions and proper classification within the mill.

As to action on sulphides, no definite conclusions can be drawn, inasmuch as the sulphide content of the ore used is low. With sufficient classification in the mill itself, however, sulphides may be withdrawn before excessive sliming takes place. It is my opinion from prolonged observation of the grinding action, that there will be less actual sliming action on sulphides than takes place in mills using steel balls for grinding media. The true slime made, which, for the purpose of the test, I took as that portion of the ground material which failed to settle in one minute standing, I found substantially free from sulphides, while that portion of the product plus 200 mesh contained much more sulphide than the average of the unsorted ore.

I am also of the opinion that if the mill were used for grinding ore preparatory to flotation of sulphide concentrate, just as close control of the grain size may be obtained as with mills using metallic balls for grinding; and, as stated, there will be less production of actual slime from the sulphides than would be the case with metallic balls.

Action on Gold Ores. The tests cited seem to warrant the conclusion that the grain size of native gold will not be reduced and that any native gold sufficiently coarse to be absorbed on an amalgam plate may, by proper adjustment of the classifier action, be retained in the classifier tank and thus concentrated to much smaller bulk before amalgamation or other process of recovery is applied. This observation applies only to native metallic gold and not to that combined or closely associated with sulphides.

Metallic gold too fine to be stopped in the classifier tanks and that too closely associated with sulphides will be recoverable in the overflow by the usual methods of cyanide or flotation or both.

Not until some time after these tests was the plant put on full-time operation. Owing to lack of sufficient ore to permit operation at full capacity, only one bucket wheel was used, and it proved able to take more than the mine output. Its capacity was actually held down to a daily average of approximately 178 tons. Cost of crushing and grinding, including all operating items, such as power, labor, repairs, and incidentals, is reported to be 19.5c. per ton.

An interesting article by John B. Huttl, in the December issue of this magazine, gave the mill flow sheet and detailed cost figures indicating that the results reported in Mr. Hall's report were bettered when the mill was in steady operation.

The mine has been taken over by the Atolia Mining Company, which is de-

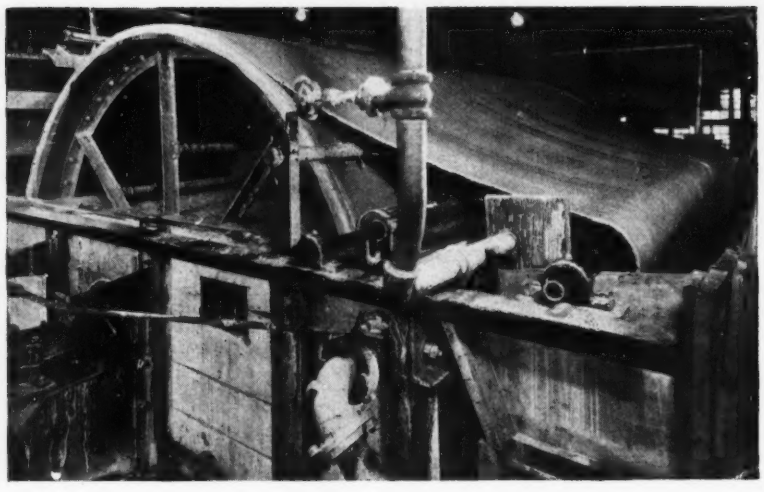
veloping the mine to increase output.

The tests made were limited by the power available and not by mill capacity. Just what the mill can ultimately do is not known; nor are data available to indicate just how it will grind other types of ores than those tested. However, during the early experiments, many different types were tested and there is no reason to believe that the mill will not grind both hard and soft ores economically. Capacity will vary with different classes of ores and the degree of reduction required.

The grinding action of the mill can be approximated by dropping carefully sized samples of ore the same height as in practice, and comparing the results with those obtained on a standard ore for which the capacity is known. Comparison as to relative grindability can then be approximated. These tests indicate quite a difference in the way various ores break up, but a difference that does not necessarily check with the grindability factors established over years with ball and tube mills. In the latter, the mill capacity is much reduced as the ore increases in hardness, whereas with the Hadsel mill this does not necessarily hold. The grindability factor does not seem to be one of hardness as much as of toughness combined with what might be called "mass tenacity." Some ores considered quite hard will chip readily. This chipping action is what is desired. Tough ores are not broken down as easily as the harder ones, particularly those ores that are rather springy in structure. In other words, an entirely new scale of grindability factors must be built up to determine the relative capacities of various mills under different operating conditions and on different ores.

Ratio of capacity to fineness is another point which will probably not work out the same as with ball mills, inasmuch as the classifying principle inherent in the new mill removes the fines produced after each drop and eliminates the effect of cushioning which is so prevalent in the operation of ball or tube mill. When the mill is used for fine grinding, say to 95 per cent through 200 mesh, it provides in this condition a much finer grinding medium than when grinding coarse, which consists of a preponderance of smaller sizes of coarse pieces. Though tending to fill the mill more than when grinding coarse, this still has the much desired effect of mass action and greatly increased surface contact. The tendency is to produce higher capacities for a given power input than would ordinarily be expected when comparing this operation with the operations of other grinding devices where the grinding media is not properly proportioned to the size of particle reduced.

[A late report states that a Hadsel mill is to be installed by the Granada company, in the Rouyn area, Quebec—EDITOR].



New Drum-type Filter Uses Endless Strings and Compression With Good Results

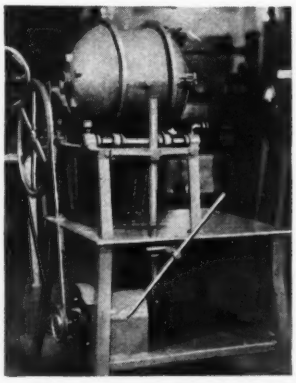
A continuous automatic drum-type filter that will discharge a cake of a thickness ranging from $\frac{3}{32}$ in. to 2 in. without the aid of either a scraper or blowback has been developed by Filtration Engineers Inc., Newark, N. J. The discharge is effected in a continuous ribbon by reinforcing the cake with endless strings and permitting it to be removed after the vacuum has been released. The strings carry the cake off in a perfect sheet, making it possible to eliminate the scraper and the blowback. The cloth is left perfectly clean. In the ordinary drum filter, as the drum emerges from the tank with its cake, the vacuum sucks out the moisture from the latter, leaving cracks and pit holes to form. In the filter under consideration, however, a compressor belt of heavy duck is applied at the point of emergence, which is driven by contact with the filter cake as the drum turns. This treatment gives the cake actual form and body. The belt is sucked on by the vacuum and closes up the cracks, thus producing a uniform cake and reducing the moisture, and at the same time eliminating all waste of vacuum, so that power requirements for the latter are much reduced. Moisture is further reduced by the use of heavy compression rolls which act by gravity and squeeze the moisture out as cake and belt pass under them. By these means, a cake having a moisture so low as to approximate the mechanical limit is produced.

By the means described, the new filter is said to be able to work effectively on products varying from the most easily filterable to those beyond the range of any other filter.

In washing cyanide slimes, the string discharge without the use of reversed compressed air is said to reduce the carbonating effect of the excess slime hydrate in the filtrate and to maintain the filter cloth and drainage members free from the scale plugging that in blowback machines necessitates frequent changing of the cloth. This also increases the capacity because of the increased porosity of the cloth.

Wire winding is not required to hold the filter cloth down or to protect it from the scraper, and there is no sealing of cloth between drum compartments. A filter cloth can be replaced in 40 min. irrespective of size.

Capacity of one filter ranges from 500 g.p.m. to 7,200 g.p.m. By combining the filter with various dyers the company claims to be able to effect a continuous filtering and drying machine that is very economical respecting labor costs.



Ball mill eases laboratory work

Laboratory Ball Mill Improved

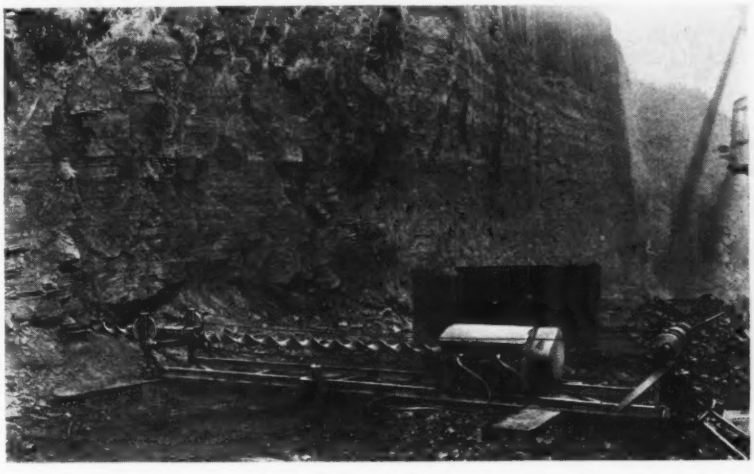
A laboratory ball mill capable of handling samples ranging from 100 grams to 12 lb. in weight and using a ball charge of 22 lb. of $1\frac{1}{4}$-, $1\frac{1}{2}$- and 2-in. balls has been developed by Braun Corporation, Ltd., Los Angeles, Calif. The mill is driven by a $\frac{1}{3}$-hp. motor. With the balls it weighs 235 lb. It occupies a space 30x30 in., and is 51 in. high over-all. The samples should be, as a rule, reduced first so as to pass a 10-mesh screen.

Auger Drills 50-Ft. Horizontal Holes

An electrically operated, horizontal drill which will drill a 3-in. hole or a 6½-in. hole horizontally to a depth of 50 ft. or more in slate, shale or other similar material has been developed by the Allendale Manufacturing Co., Indianapolis, Ind. This company is said to be the licensor of a new method of placing, loading and shooting holes so drilled as to produce fragmentation of earth structures cheaply and efficiently. The method involves use of the drill.

Advantages claimed for the method are that the cost per foot of hole is less than when vertical drill apparatus is used; less feet of hole per cubic yard of material is required; cost of blasting is reduced because a cheaper explosive can generally be used for the reason that dry holes are more often obtained; and better fragmentation can be effected because the explosive can be placed where most needed.

The general construction of the machine is shown in a cut. Drilling is done by an auger driven by a drill spindle mounted on Hyatt bearings, the entire mechanism being supported on a base consisting of two 35-lb. rails braced and tied together by welded struts to form a 28-in. gage track 15 ft. long. The auger is guided at the proper height by suitable means and is pulled into the work by means of wire ropes which pass over sheaves at the end of the base. A 7½-hp. motor is used.



Novel long-hole auger drill for use with newly devised mining method

The machine was designed primarily for strip mining but is also offered to anyone who has to use explosives in loosening stratified material where a vertical face presents itself and the material can be penetrated by such a drill.

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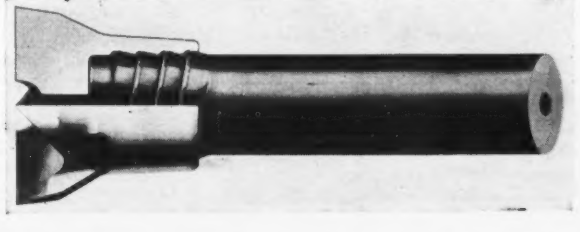
Another New Detachable Drill Bit

A one-piece detachable bit for rock drills with drill rods to correspond has been under development by the Ingersoll-Rand Company, New York, for some time past and has just now been announced. It has been given the name of "Jackbit." Its features are amply illustrated in the accompanying cut. A left-hand threaded joint is used, the bit being the female end. The thread is shallow, as may be seen, and because of its characteristics is termed a reversed buttress type. The angle of the thread has been carefully determined. Thanks to the careful working out of these details, a joint has been produced which, it is said, can easily be made tight for operation and readily loosened by a hammer tap. The thread, moreover, does not become loose with wear. The bit is of the double-taper four-point type and will be made in six gages from 2¼ in. to 1⅝ in. The maximum hammer blow is said to be transmitted to the cutting edge through the full area of the end of the drill rod, and none of it through the threads. Clearance grooves are large, facilitating removal of cuttings. Bits are hardened to a depth that will permit two or three regrindings. They are cadmium-plated, with attendant advantages.

The company is ready to supply drill rods of ⅞-in. and 1-in. hexagonal steel, properly shanked and of a composition suitable to the service demands made upon it. The steel is hollow, having a smooth, uniform hole made by a special process.



The Jackbit has a left-hand threaded joint of novel characteristics

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More Facts on the Crusca Bit

The November issue of *Engineering and Mining Journal* contained a short announcement of the introduction of the so-called Crusca detachable bit by the Crucible Steel Company of America, New York. That company has just made the further announcement that its bit (also a one-piece bit) is being made in three groups to fit the Crusca shank steel. These are designated as groups A, B and C. Bits of group A fit on 1-in. hollow round steel with ⅞-in. hexagon x 3½-in. long shanks. Those of the B group fit on 1⅛-in. hollow round steel with 1-in. hexagon x 4½-in. long shanks. Group C bits fit on 1¼-in. hollow round steel with standard lugged shanks.

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BULLETINS

Gold Mining Machinery. W. W. Gibson, San Francisco, Calif., and Ottawa, Ont. Catalog No. 14. Pp. 36.

Gold Recovery Plants. Denver Equipment Co., Denver, Colo. Bulletin 3207, "Small Gold Plants Can Pay Profits." Pp. 4.

Conveying. Robins Conveying Belt Co. Bulletin 82, "Robins Belt Conveyors—A Handbook for Designers." Pp. 100.

Conveying. B. F. Goodrich Rubber Co., Akron, Ohio. Circular 2260. Maxecon general-service conveyor belt. Pp. 4.

Conveying. Stephens-Adamson Manufacturing Co., Aurora, Ill. The Redler conveyor. Pp. 4.

Generators. General Electric Co., Schenectady, N. Y. Bulletin GEA-383D. Low-speed a.-c. generators.

Steam Turbines. General Electric Co., Schenectady, N. Y. Bulletin GEA-1145B. Steam turbines for mechanical drive of pumps, fans, compressors, blowers, pulverizers, and stokers. Pp. 16.

Electric Heating Units. General Electric Co., Schenectady, N. Y. Bulletin GEA-1520 A. Pp. 36.

Manganese Steel. Taylor-Wharton Iron & Steel Co., High Bridge, N. J. Bulletin entitled "Tisco manganese steel castings as applied to gold, platinum, and tin dredges for alluvial mining." Pp. 31,

TRENDS AND DEVELOPMENTS IN THE INDUSTRY

NORTHWEST

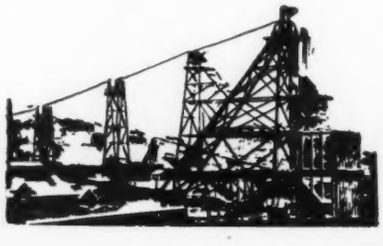
Flotation of River Gravels.—Investigations conducted by A. W. Fahrenwald, professor of metallurgy and ore dressing at the School of Mines of the University of Idaho, have demonstrated the extent to which free gold could be recovered by the flotation process. Much attention is being given to the possibility that flotation is the solution of the "flour" gold problem, which has troubled placer miners working along rivers and sand bars since the early days. "Gold is easily floatable," Professor Fahrenwald points out, "and if in not too coarse a form it can be recovered from finely crushed gold ore or from placer sand such as occurs on the Snake, Columbia, and other rivers in the Northwest. Recovery of gold from a black-sand concentrate made by washing the placer sand over a concentrating table, through a sluice box, or by gravity treatment, presents a difficult problem. The miner works up his product for its gold content by amalgamation with mercury, or by carefully panning it. The reject from either of these treatments, rich in gold, is lost. Flotation has given almost complete recovery of gold from this material. Flour gold in river-bar sands, only a small percentage of which can be caught by dredging, is readily recovered by flotation. The gravel is screened on a 14- to 20-mesh screen to remove coarse sand, pebbles, and boulders. The product passing through the screen can then be floated direct. Concentrate produced usually does not weigh more than one one-hundredth part of the original, and assays $100 to $1,000 a ton. The gold floated from black-sand concentrate is nearly pure gold, only little of the sand floating. "River sand containing as little as 50c. a yard could be treated profitably if handled on a large tonnage basis," avers Professor Fahrenwald. "Excavation by steam shovels, screening, and flotation should not cost more than 25 to 30c. a yard. A 1,000-yd. a day plant should yield a profit of $200 to $250 a day. The first cost of a plant of this size would be about $25,000."

University Sponsors Mining Institute.—The annual Mining Institute sponsored by the mining department of the University of Washington was held at the mines laboratory during the week of Jan. 16-21. The program consisted of a series of lectures, with laboratory demonstrations of methods, processes, and equipment used in the mineral industries. A field trip was arranged to study the operation of boring equipment and methods. Dean Milnor Roberts and members of the faculty supplied lectures and instruction, and special speakers included the following: T. A. Rickard, on "Mining of the Romans"; Paul Billingsley, on "Trends of Thought in Ore Hunting"; N. C. Jannsen, on "Deep Placer Mining"; G. F. Kuentzel, on "Churn Drill for Gold Prospecting"; W. J. Elmendorf, on "Typical Examination and Report of a Gold Mine"; J. L. McAllen, on "Gold Milling"; Harold Smith, on "Operations at the Treadwell Yukon."

Activity Expected in Central Idaho.—Significant mining developments are expected to take place in Central Idaho in 1933. The area, scene of repeated gold rushes in pioneer times, includes five mining districts—Elk City, Dixie, Orogrande, Ten Mile, and Buffalo Hump. Adventurers of another generation skimmed the more easily accessible deposits of placer gold. The quartz ledges were not attractive then, because of their inaccessibility; the deeper and lower-grade placer grounds could not be worked, because machinery could not be taken in over the rough mountain trails. Those districts are no longer inaccessible. The federal government has for ten years been pushing highways into the mountains and up the south fork of the Clearwater. This spring autos and trucks will begin pouring in men, supplies, and machinery from Spokane, Lewiston, and other points, and more freight will go in by truck from the two railway terminals at Stites and Grangeville.

WASHINGTON, D. C.

Assessment Exemption Bill Passed.—A bill by Senator Borah, Republican, Idaho, to exempt unpatented mining claims from the requirement that their claimants must do $100 worth of work on them each year was approved by the Senate mines committee on Jan. 7. The exemption would apply from July 1, 1932, to July 1, 1933. Before the measure was favorably reported, however, the committee adopted an amendment by Senator Hayden, Arizona, which required persons or corporations paying federal income tax for 1932 to perform their claim work. Those entitled to exemption would, under the provisions of the Hayden amendment, be required to file notice that they owed no income tax for 1932.



CALIFORNIA

Pyrite Mine Reopens.—Steady demand for pyrites is responsible for the reopening of the Hornet mine, near Matheson, by Mountain Copper. The mine contains one of the largest deposits of pyrite in California. A production of 150 tons a day is planned. At its Iron Mountain mines, the company is treating 600 tons of gold-bearing gossan a day, with 100 men employed steadily. . . . Early construction of a 200 ton mill is being planned by Empress Mining, operating the principal properties in the Newton area between Grass Valley and Nevada City. . . . About 2,000 men are estimated to be employed in the Grass Valley-Nevada City sector. The mills of Empire-Star, Idaho-Maryland, Hoge Development, and Empress Mining are operating at capacity. Idaho-Maryland also reports a new strike on the 1,200-ft. level. The vein is 16 ft. wide at the discovery point and of high milling grade. . . . Rehabilitation of the historic Porter gold property in the Yankee Hill district is being undertaken by Madre de Oro Mining, headed by A. H. W. Faber. The mine, idle for nearly fifty years, is said to contain a large tonnage of milling ore.

Carson Hill Gold reports satisfactory progress in the rehabilitation of its property at Melones and development work in the Morgan and Santa Cruz areas. The rehabilitation program includes the repairing of the 1,100-ft. level haulage tunnel, above which, according to estimates, over 4,000,000 tons of low-grade ore is available, and overhauling of the 750-ton mill. Construction of a 2,000-ton mill is contemplated. The company also reports the discovery of an orebody in the Calaveras tunnel, said to average $12 per ton. . . . Louis Upton is operating the Francis mine near Brownsville and has installed a stamp mill and an air compressor. The shaft is to be deepened to 200 ft. . . . Oro Quartz has been taken under bond and lease by the Oro Mining, of San Francisco. Machinery is to be installed at once.

Bradley Interests Active.—Preparations are being made to reopen the Spanish mine, on Poorman Creek. The mine, staked in 1896 by F. Dillon, is owned by F. Bradley. About 40 men are to be employed under the direction of James Bradley. . . . Atolia Syndicate, a Bradley subsidiary, has acquired the holdings of the Eureka-Woodside, adjoining the Beebe mine purchased recently. The Eureka-Woodside mine will be worked from the 130-ft. level of the Beebe with two shifts employed. P. R. Bradley, Jr., and A. V. Udell, superintendent and operating engineer respectively, are in charge. . . . Consolidated Bullion, Inc., has started preliminary work on the old Bullion

group of gold claims at Grass Valley. The corporation controls, besides the Bullion mine, several adjacent claims in the Allison Ranch-Osborne Hill area, and is understood to be arranging for activities on a large scale. . . . Work has been resumed at the Murchie mine, after a brief shutdown, affecting 200 men, caused by a skip falling from the 900-ft. to the 1,600-ft. level because of a clutch and emergency brake failure on the hoist. Considerable damage was done to the shaft timbers. . . . National Merger Gold Mines of New York has purchased the Scales property, in northern Sierra County, and plans installation of equipment. The property covers 2,100 acres on Rock Creek, with ample water available for mining operations. . . . The Hudson Bay shaft, a unit of Empire-Star Mines at Grass Valley, has been bonded to D. C. Sharpstone, who is assembling machinery for reopening the property. Power will be obtained from the central plant of Empire-Star, a line now being under construction.

ARIZONA

Profitable Placer Operations.—Few placer miners are said to make good wages, but A. E. Lewis, who is leasing the Arizona Gold Mines property four miles southwest of Kingman, has found placer ground in a gulch below the low grade vein, some of which runs as high as $25 per yard. He has shipped nearly $1,000 in gold to the Denver mint since starting operations in the fall. Working alone, he produces from $6 to $10 in gold per day. His equipment consists of two sluice boxes and an amalgamating plate. Water is pumped from a well half a mile distant. . . . In the Gold Basin district, 60 miles north of Kingman, five men, under the direction of J. E. Mitchell, are sampling and test pitting sections 21 and 29 of Township 29 North, Range 18 West, which the company has leased from the land department of the Santa Fe R.R. Mr. Mitchell, who at one time operated the Evahom mine, at Mineral Park, states that of 700 samples so far taken and run through a dry washer, the value in gold averaged $1 per cubic yard. The chief drawback to mining in this part of the State is the lack of water. Gold Basin is considering laying a 6-in. pipe line to its ground from the Colorado River, distant 8 miles. . . . On lower Lynx Creek in Yavapai County, the Harp & McGuire company is operating a dredge of standard gold-dredge design except that it has no digging ladder. The gravel is dug and carried to the dredge by a drag line excavator. The dredge equipment consists of a 12-in. grizzly, a reciprocating feeder that feeds from a hopper into a 4½x27-ft. friction drive, trunnion-type trommel screen having ⅝-in. openings, 500 sq.ft. of sluice boxes, equipped with Australian-type riffles, four Neil jigs, a 3-in. sand pump, and an amalgamator. Dewatered waste material is stacked behind the dredge with an 85-ft. stacker belt. The value of the gravel is reported as 40c. per yard. The property is operated under lease from Arizona Dredging & Power, and the owner is G. S. Fitzmaurice, of Prescott. Water for the project is impounded in a 60-ft. concrete dam a mile above the present operating point. The dredge circulates 3,000 gal. per minute of water from the pond, and consumption is 1,000 gal. per minute. The barge is 50 ft. long, 32 ft. wide and 5 ft. deep. Draft is 3 ft. . . . In Spruce Canyon, also in Yavapai County, Hoosier Engineering, of Chicago, is testing placer ground said to run from 53c. to $1.25 per yard.

Metallurgical Plants Operating.—During 1932 the largest producer in the Black Canyon district, south of Prescott, was the Golden Belt mine, a mile east of Cleator. The 50-ton flotation mill on the property is working three shifts. A carload of concentrate is shipped about once a week, and the value of the last car is said to have been $6,000. Smaller producing mines in this district are the Schutz brothers' Turkey mine, the Silver Chord, operated by Dick McCutcheon; the Gold Money mine; and the Cleator, in the town of Cleator, where Mr. Cleator has been crushing ore with an Ellis ball mill. . . . At Radium, between Globe and Miami, the Last Hope mine, a gold property, after being shut down for a year, is resuming work. According to Michael Moran, manager, $5 to $10 ore has been developed and will be treated in the company's amalgamation mill. . . . At the Jaeger mine, near Tucson, the shaft has been sunk to 215 ft. and drifting is now being done on the 200-ft. level. The property is under lease to Akron Gold Mining. . . . Operation of the Phelps Dodge smelter at Douglas was resumed for a short run on Jan. 9.

NEVADA

Flotation of Comstock Ores.—Arizona-Comstock Corporation has started operating a 150-ton flotation plant at Virginia City, the first adaptation of that process on Comstock ores. The company is operating the Hale & Norcross, Chollar, Potosi, and Savage mines through the Hale & Norcross tunnel. Ore is transported by electric trains to a 150-ton bin, from which the product is fed to a 10x20 Gates type jaw crusher, thence over a short belt conveyor to a No. 25 Kennedy crusher, which breaks the ore to ⅜-in. Crushed ore is belt conveyed to a 200-ton bin and fed thence to a 64½-in. Marcy ball mill, operating in closed circuit with a duplex Dorr classifier. The ball mill grinds to 80 mesh, and the classified product passes to eight Sub-A Denver flotation cells, seven rougheners, and one cleaner. Concentrate is pumped to an 8x8-ft. thickener tank and flows thence to a 4x6-ft. Oliver filter. From the filter the concentrate passes to the drying room. American Cyanamid Aerofloat reagents are used, No. 301, amyl xanthate, 0.05 lb. per ton of ore; No. 208, 0.05 lb.; Aerofloat No. 15, 0.01 lb. Mill heads average $10 a ton. Laboratory tests on this grade of ore by Pan-American Engineering Corporation, Berkeley, Calif., gave a recovery of 89.90 per cent gold and 92.12 per cent silver on ore assaying 0.49 oz. gold and 16.5 oz. silver. Analysis of the sample submitted, from the Chollar mine, showed silver sulphide, partly free gold, and gold- and silver-bearing pyrite in a siliceous gangue. Operating costs, mine and mill, are estimated at $3 a ton, and milling costs will be $1.25 a ton less than by cyanidation. Howard W. Squires is general manager and A. J. Hilton is mill superintendent. The mill was built by Rosenburg & Company, Los Angeles. Concentrate will be shipped by trucks in 10-ton lots to a smelter in Utah, or to the Selby plant on San Francisco Bay. Concentration is at the ratio 124:1.

Development at Goodsprings. — Six miners at Goodsprings have developed a large body of gold ore in dolomite limestone at the Chiquita mine and have 400 sacks to ship which they report assays $158 a ton. The ore is a replacement of the limestone and averages 20 feet wide. The mine is about a mile from the old Keystone. J. H. Smith and partners, the miners, worked on a grubstake from O. F. Schwartz, Goodsprings store-keeper. They have incorporated Chiquita Mining Company and purpose to build a mill at Sandy Flat, three miles from the mine. The ore, it is claimed, averages $30.10 per ton. It is siliceous and contains a considerable quantity of iron oxide. . . . Receipts of gold and silver at the government assay office, formerly a mint at Carson City, will exceed $250,000 for the fiscal year ending June 30, 1933, according to estimate of E. T. Clyde, superintendent. Receipts to Jan. 7 totaled $134,000 and should be larger for the last six months of the year. Gold predominates, there being very little silver in the bullion from mills. A considerable quantity of placer gold was received, from various parts of the State. Three mills on the Comstock lode in the Silver City end of the district produced more than half the gold received. Nearly all the shipments were small lots, from amalgamating mills and placer mines.

MONTANA

Gold Receiving Major Attention.—Kirk-Arnott Oil, of Frannie, Wyo., has taken over the Chile group of gold claims from the John King estate and the adjoining Peacock group from John L. Templeman, attorney for the W. A. Clark estate, near Harrison, Madison County. Arrangements are being made to unwater the shaft and explore the lower workings. E. Mason is in charge. . . . Empire Gold Mines has been organized in Delaware to take over and operate the Empire, Smithville, and Whipperwill group of claims on the west flank of Belmont Mountain, Marysville district, Lewis and Clark County. Properties consist of twenty patented gold claims. The mill is expected to be rehabilitated. Meanwhile, shipping ore is to be extracted from the mine. Work will be under supervision of W. M. Manning. . . . Milton I. Leydig, formerly in charge of Ruby Gulch Mining operations, and associates are operating the Gold Crown claim east of Bannack, Beaverhead County. Property has recently been equipped with gasoline-driven compressor and hoist. Shipments of ore will start immediately. . . . Anaconda Copper is starting its zinc refinery at Great Falls, to refine

an accumulation of zinc at the plant. This will give employment to 200 men, but the company is not contemplating starting any of its zinc mines.

Development in Basin District.—A region in which much mining activity is expected this year, especially gold mining, is the Cataract district, adjacent to the town of Basin, about 29 miles from Butte. During the past two years miners and prospectors have been busy digging around the hills tributary to the creeks and gulches to the south of the town. Probably the foremost discovery was in the vicinity of Pole Mountain. The principal claim was taken over last September by Basin Goldfields, by which company it has been since operated. The company now controls five claims, and all of the work has been done through crosscut tunnels. Butte Copper Consolidated has purchased an interest in Basin Goldfields. Basin Goldfields expects soon to install machinery and continue development underground. . . . On Cataract Creek the principal operation is that of the Morning Glory group, operated by Carl Anderson, L. D. Hudson, and L. F. Hachez, of Spokane. This property formerly was owned by White & Hutchison, of Basin and Butte, and the developments during the last six months have opened a body of shipping gold ore. Negotiations are being conducted to equip the property. . . . Southern claims of Basin Montana Tunnel, on Comstock Hill, showing gold ore, are being developed under the supervision of Leo Coady. . . . Roy Miller, Inc., of Portland, Ore., recently took over the Jib group of claims in the town of Basin and surrounding it on all sides. This property was the mining sensation of Montana in 1924. Mr. Miller plans to unwater the properties and overhaul the mill so that it can be started in the spring. A tailing pile of over 40,000 tons is said to contain gold recoverable at a profit. Both mine and mill are equipped with modern machinery, operated by electric power. . . . Equipment for a 60-ton mill has been assembled at Virginia City, for the Prospect group of mines of Virginia City Gold Mining. The mill is expected to be in operation by early spring.

COPPER COUNTRY

Position of Copper Range Favorable.—About two-thirds of current production of Copper Range is going to C. G. Hussey & Company, of Pittsburgh, in which Copper Range owns a controlling interest. Thus a dependable outlet for a substantial part of the output has been established. Sheet copper in various forms is fabricated by Hussey company, other articles including copper nails, rivets, ferrules, and building materials such as shingles, gutters, conductor pipe, and ridging. Prospects for profitable mining operations also are regarded as encouraging. The company's efforts have been centered on a drastic reduction in costs, and heroic measures have been taken to bring this about. Success has attended all of these steps to date. Included among them are the development of cheap hydraulic power on the Ontonagon River in Ontonagon County; remodeling of the stamp mill for flotation; the adoption of the sublevel caving system of mining; a general reduction of overhead; and economies by readjustments. Another revolutionary step is to be taken in the installation of cone crushers in the mill. Experimental work indicates the success of the new crushers, and if they work out successfully in practice, the steam stamp heads will be discarded. A considerable saving in production cost is expected as a result. The company has cut its force and reduced operations to five days a week. Production, which has been about 1,000,000 lb. of copper a month, will be further reduced.

MEXICO

Gold Mining in Guerrero.—Considerable activity is reported from the Taxco and El Monte regions of the State of Guerrero. A lease has been taken on the Sorpresa, Minerva, and Juliantla properties near Taxco by General Minerals. Lowell Ridings is president. This company is modernizing a plant at the town of Atlixhuaya so that it can handle about 50 tons per day. Cia. Minera de Atlixtac, also operating in the Taxco region, is intensifying its explorations, and George Petit, owner of property at Tehuilotepec, adjoining lands held by General Minerals, is conducting explorations. . . . Cia. Minera de Chontalpan has intensified work in its Xitinga mine, in the El Monte district between Taxco and Zacualpan, and has opened an automobile road from its properties to Taxco. New machinery for the San Miguel del Monte mine, in the El Monte district, and a near-by mill will be installed soon by the Cia. Minera del Monte, which is also draining the mine's lower levels. Los Membrillos mine, near El Monte, is being drained by the Cia. Minera de los Membrillos in preparation for operation. . . . Four dismissed miners of the Real del Monte y Pachuca Mining have been handed over to the Pachuca police on the charge that they stole 76 kilos of metal from the company's La Rica mine. Company guards caught the accused as they were leaving the mine. . . . After having been suspended for nearly a year, work has been resumed by mills at La Palma and Cerro de Oro, in the Carbo district, Sonora. The former mill is handling ore from the Louisa mine, both properties being owned by Verdina Mining. The latter mill is treating ore of the Sultana mine. A. T. Cooper, of Webster, S. D., owns the latter mill and mine. . . . Another mining area has been declared part of the national mineral reserves for the exploitation of gold and silver by the Ministry of Industry, Commerce & Labor. The tract is in Bravos municipality, in the State of Guerrero. The Ministry announces that it will respect existing claims in the tract held by companies and individuals, as well as pending applications for claims in the region.

Beryllium in Sonora.—A tract on the west side of the Cordon de la Bolsa in the Sierra de la Madera, Moctezuma municipality, in the State of Sonora, has been declared by the Ministry as part of the national mineral reserves for the exploitation of beryllium. . . . The mining industry is generally benefited by the increased worth of American and British currencies against Mexican money, because foreign buyers can acquire silver, copper, lead, and zinc at bargain prices, contends the Ministry of Industry, Commerce & Labor. The Ministry's mines department reports that last year Mexico sold 5,875,000 oz. silver to buyers paying with dollars or pounds sterling, and that Mexican exporters profited by these transactions, although the price had dropped to 24c. per ounce. Mexican lead mines were able to keep going with their sales abroad even though price of the metal had fallen to 3c. a pound, the department finds. . . . Twenty thousand metric tons of lead was dispatched during December for Europe through Tampico, announces the mines department of the Ministry of Industry, Commerce & Labor. The movement represented the heaviest shipment of the metal to Europe in recent months. Demand for Mexican lead in Europe has increased considerably during the past few months. . . . Contending that Mexico's chief copper markets are in Canada and Europe, the Ministry of Industry, Commerce & Labor asserts that the proposed increase of one cent per pound in American import levies on the metal will not be prejudicial to the Mexican production, sales, or exportation of copper. . . . The Territory of Lower California government has commissioned Engineer Rafael Sierra Dominguez, president of the Peninsular Agricultural Credit Bank of Mexicali, to inspect the San Quintin Valley, south of that town, to ascertain the possibility of exploiting commercially gold, silver, and other mineral lands in that region.

CANADA

Promising Developments in Northern Quebec. Three of the gold discoveries made last fall in widely separated parts of the northern Quebec gold area are responding well to preliminary development. Their discovery ten years after the first rush of prospectors to the district illustrates how difficult it is to find the veins in an area heavily covered with forest and mantled with soil. . . . Shallow diamond-drilling of the McWatters vein structure, two miles from the eastern boundary of Rouyn Township, has now established the continuance underground of the rich quartz lenses found on surface. As the values are erratic, drilling is not particularly satisfactory, and a portable mining plant has been installed to start a shaft. The system of quartz veins and stringers composing the gold-bearing zone occur in a shear zone in Timiskaming conglomerate. . . . Sixty miles to the northeast is the Tremblay find—a substantial quartz vein in Keewatin lava. This vein, well mineralized, contains much visible gold, assays being high. As yet too little stripping has been done to judge the volume of the quartz. Randall Mines Corporation, financed by N. A. Timmins, Ventures, Ltd., and Consolidated Mining & Smelting, has been formed to develop the property, which covers an area of 12 square miles east of Fisher, including the showings of Fisher Gold Mines and Venus Gold

Mines. Bulk samples from the Tremblay vein are now being treated in the 25-ton mill at the Venus property, and a shaft is under way to explore the vein to a depth of 250 ft. . . . Ninety miles east of Rouyn, at the eastern end of the well-marked gold belt that extends for 150 miles in Ontario and Quebec, is the Woods find, in Tiblemont Township. The 800-acre group is under option to Hollinger Consolidated, engaged in developing it vigorously. The showing consists of irregular veins and stringers of gold-bearing quartz in monzonite near its contact with Keewatin greenstone. In occurrence the ore is typical of the gold deposits of this area, of which the Siscoe is the best developed. There is little mineralization of either the quartz or the wall rock, and the gold is largely in visible particles, often large. Extensive surface stripping and sampling indicate a rather broad zone containing a considerable proportion of quartz with above-average gold content. . . . These three properties indicate the present activity through the 100-mile gold belt of northwestern Quebec and the promising nature of the prospects recently uncovered. The Granada, Cadillac-O'Brien, and Siscoe gold mines, already in steady production at widely separated points, mark only the beginning of what promises to be a highly productive area.

Salt for Road Surfacing. Malagash Salt, which showed a substantial increase of output during 1932 from its mine at Malagash, is developing a new outlet for its lower-grade product as a road surfacing material; salt in admixture with certain kinds of clay has been found to form a permanently plastic and durable binder for gravel. A road surfaced with an inch or so of this material is dustless and resists wear. . . . Falconbridge Nickel Mines entered the ranks of dividend paying companies in January, with an initial payment of 10c. a share, totaling $320,000, of which about one-half will go to Ventures, Ltd., its principal financial sponsor. The surplus nickel stocks of a year ago have now all been sold, all current production is contracted for, and the increased output now coming from the smelter is required to fill orders for the present year. . . . Ventures, Ltd., has taken over Galatea Gold Mines through an option on treasury stock and is diamond-drilling the property, which adjoins the Beattie gold mine, north of Rouyn, Que., on the east. The Galatea showing is essentially the same as that now developed on the Beattie, but insufficient work has been done as yet to determine the average value of the large deposit indicated by surface trenching and preliminary diamond drilling.

Copper Increases in Radium-Silver Ore.—The radium-silver ore at Great Bear Lake has now been proven to a depth of 100 ft. The vein at the intersection is 20 ft. wide, including irregularly disposed silver and radium, with much more copper than is found at the surface. Drifting is now proceeding both ways on the vein, to get underneath the points at surface whence rich ore has been obtained and where shoots of high-grade material are indicated. . . . A prospecting party of the Cyril Knight Exploration Company, headed by W. B. Airth, located last summer at the northwest tip of Ungava, east of Fort Smith, large areas of sulphides, largely pyrite and pyrrhotite, which extend for miles along the coast and for long distances inland. No commercial ore has been found, but the area offers excellent chances for prospecting, in the opinion of Mr. Airth, on account of the large size of the sulphide deposits and because small amounts of gold, silver, nickel, and copper have been identified in them.

Howey Gold to Enlarge Mill. Howey Gold will increase mill capacity by 40 per cent, to 1,300 tons daily, next summer. Partial development of the two new levels at 1,175 and 1,300 ft. has assured an adequate tonnage for the enlarged mill; and, as the cost will be lowered about 50c. a ton, to $2, an additional tonnage of ore on the upper levels can be treated profitably.

AUSTRALASIA

Progress Along Golden Mile.—Broken Hill Proprietary is preparing for the erection of a treatment plant on its Hannan's mine at Kalgoorlie, Western Australia. During the eight months in which the company held a working option over the mine, sufficient ore was developed to justify erection of a mill. . . . Boulder Perseverance's new bromo-cyanide plant, erected at a cost of £62,000 (Australian currency), is now treating the entire mine output of 7,500 tons monthly, the recovery being 93 per cent. . . . Paringa Mining & Exploration, which holds a lease adjoining the North Kalgurli and Associated Northern properties, has made arrangements for a diamond-drilling program to be carried out under the general supervision of T. Blatchford, government geologist. . . . The Privy Council has decided that tributers on the Kalgoorlie field are entitled to participate in the gold premium, which at the present time is £3/14/- per ounce of fine gold, and £150,000 will soon be distributed among 500 men, some of whom will receive over £3,000.

Important Gold Field Developing.—Development work being carried out on the Cracow gold field, Queensland, is proving that the orebodies will ultimately be of great extent, but perhaps of low grade. Golden Mile (Cracow) is installing a 240-hp. oil engine, air compressor, and grinding equipment. Golden Plateau, a second company operating at Cracow, plans to erect a 100-ton mill, for the cost of which fresh capital is to be raised. Total mining and milling costs are expected not to exceed 16s. per ton. B. Dunstan, formerly chief government geologist of Queensland, states that the field is an important one, and that the gold-bearing reefs will be likely to continue in depth. . . . Mount Morgan announces that in the main orebody there is at least 1,500,000 tons of payable gold ore available for treatment. The mill is to be extended, by the addition of fine grinding and flotation equipment, to have a capacity of 500 tons daily. Additional capital for mill extensions is to be raised. During the twelve months ended June 28 last, the company produced 126¾ tons of copper precipitate, containing 88½ tons of copper, from underground leaching, the loss for the period being £12,577. Leaching has now been discontinued.

Three-Year Agreement Signed.—The Broken Hill miners have made a wage agreement for a period of three years with the operating companies. Under this new agreement, the men will receive a basic wage of 14s. per day, or £4 4s. per week, plus a bonus of 6d. per day when the price of lead rises above £17, and a further bonus of 6d. when lead rises above £18 per ton. With lead above £20 per ton, an increase of 6d. per day will be paid for each £1 rise in the price, with a maximum of 20s. per day. . . . A company has been formed to unwater and further develop the Occidental mine, at Cobar, N.S.W. A winze is to be sunk below the 740-ft. level and the extent of the orebody determined. The Occidental mine has great possibilities. It was first worked as a copper mine, but gold values increased in a remarkable manner with depth; and up to 1918 over 800,000 tons of sulphide ore, assaying 10 dwt. gold, was treated by tabling to remove pyritic concentrates, roasting and cyaniding. The orebodies are large, lenticular along the strike, and cut across sandstone country. . . . Gold-mining companies formed during recent weeks include New Morning Star, to reopen and develop the old Morning Star mine in the Woods's Point district (Vic.); Sheoak Central Gold to develop an area at Moliagul (Vic.); Big Hill Gold to reopen the Big Hill mine at Bendigo; South Virginia Gold to develop a property at Eaglehawk (Vic.); Argyle Gold to unwater mines at Heathcote (Vic.) and Croydon; Pearl Gold, to acquire leases at Maryborough (Vic.). . . . Under an additional grant from the Commonwealth Government, rapid progress has been made at Moonta Mines, South Australia, preparing new orebodies for extraction and in building a flotation plant. Ore reserves total 31,000 tons assaying 5 per cent copper, and 2,500 tons assaying 6 per cent is at grass.

AFRICA

Nigel Mine May Be Reopened. Encouraged by the favorable returns from the neighboring Sub Nigel, the directors of the Nigel company are considering merging the property with adjacent areas and resuming operations. A factor of considerable importance is that as a result of drilling on Vlakfontein No. 21, the sub-outcrop of the Main Reef Leader has now been found to extend much further to the east than was formerly believed. This should have a favorable effect on all properties that are situated, like the Nigel, on the rim of the Far East Rand Basin.

Gold Mining in Rhodesia. The gold boom in Southern Rhodesia continues, late returns showing a record, particularly in number of producing properties. The total is nearly 400, compared with about 200 a year ago. In addition, several new properties are in the development stage, many on the eve of initial output. A demand has arisen for three- and five-stamp mills. Increase in production is general throughout the colony, but the highest output is in the Gwelo district, followed by Hartley, both of which are favorite areas with the small worker and prospector.

Daily and Average Monthly Prices of Metals

January, 1933

United States Market

Jan.	Electrolytic Copper: Domestic Refinery	Electrolytic Copper: Export Refinery	Straits Tin New York	Lead: New York	Lead: St. Louis	Zinc St. Louis
2	Holiday	4.825	Holiday			
3	4.775	4.825	22.500	3.000	2.875	3.125
4	4.775	4.800	21.750	3.000	2.875	3.125
5	4.775	4.725	22.300	3.000	2.875	3.100@3.125
6	4.775	4.725	22.350	3.000	2.875	3.100@3.125
7	4.775	4.700	22.400	3.000	2.875	3.100@3.125
9	4.775	4.725	22.550	3.000	2.875	3.100@3.125
10	4.775	4.775	22.700	3.000	2.875	3.085@3.100
11	4.775	4.850	22.900	3.000	2.875	3.100
12	4.775	4.850	22.850	3.000	2.875	3.025
13	4.775	4.825	22.450	3.000	2.875	3.025
14	4.775	4.750	22.450	3.000	2.875	3.025
16	4.775	4.750	22.400	3.000	2.875	3.000
17	4.775	4.700	22.700	3.000	2.875	3.000
18	4.775	4.700	22.625	3.000	2.875	3.000
19	4.775	4.675	22.400	3.000	2.875	3.000
20	4.775	4.650	22.650	3.000	2.875	2.950@3.000
21	4.775	4.675	22.750	3.000	2.875	3.000
23	4.775	4.675	22.800	3.000	2.875	3.000
24	4.775	4.725	23.000	3.000	2.875	2.950@3.000
25	4.775	4.750	23.125	3.000	2.875	2.950@3.000
26	4.775	4.750	23.125	3.000	2.875	2.950
27	4.775	4.725	23.000	3.000	2.875	2.900@2.950
28	4.775	4.725	23.000	3.000	2.875	2.900@2.950
30	4.775	4.675	23.100	3.000	2.875	2.900
31	4.775	4.725	23.425	3.000	2.875	2.850
Av. for Month	4.775	4.741	22.692	3.000	2.875	3.018
			Averages for Week			
4	4.775	4.808	22.500	3.000	2.875	3.125
11	4.775	4.750	22.533	3.000	2.875	3.107
18	4.775	4.763	22.579	3.000	2.875	3.013
25	4.775	4.692	22.788	3.000	2.875	2.988
			Calendar Week Averages			
7	4.775	4.767	22.260	3.000	2.875	3.118
14	4.775	4.796	22.650	3.000	2.875	3.063
21	4.775	4.692	22.588	3.000	2.875	2.996
28	4.775	4.725	23.008	3.000	2.875	2.958

Silver, Gold, and Sterling Exchange New York and London

Jan.	Sterling Exchange: "Checks"	Sterling Exchange: "90-Day Demand"	Silver: New York	Silver: London	Gold London
2	Holiday				
3	3.337500	3.341250	24.500	16.5000	123s 8d
4	3.333750	3.338750	24.875	16.5625	123s 4d
5	3.342500	3.346250	25.375	16.8750	123s 11½d
6	3.343750	3.348750	25.000	16.6875	123s 11½d
7	3.340000	3.343750	25.000	16.6875	.....
9	3.346250	3.350000	25.250	16.8125	123s ...
10	3.351250	3.357500	25.125	16.7500	122s 10d
11	3.352500	3.360000	25.375	16.8750	122s 8½d
12	3.353750	3.361250	25.250	16.9375	122s 8½d
13	3.350000	3.356250	25.125	16.8750	123s 2d
14	3.353750	3.360000	25.250	16.8125	.....
16	3.357500	3.365000	25.375	16.8750	122s 8½d
17	3.347500	3.355000	25.250	16.8125	122s 8d
18	3.346250	3.352500	25.500	16.8750	123s ...
19	3.347500	3.353750	25.375	16.9375	122s 11d
20	3.352500	3.361250	25.375	16.9375	122s 10d
21	3.357500	3.362500	25.375	16.8750	.....
23	3.363750	3.368750	25.625	16.9375	122s 7d
24	3.397500	3.405000	26.250	17.1250	121s 7d
25	3.393750	3.403750	26.000	17.0625	121s 11½d
26	3.393750	3.403750	25.750	17.0625	121s 4½d
27	3.381250	3.387500	25.500	17.0000	121s 5½1
28	3.381250	3.392500	25.625	17.0000	.....
30	3.392500	3.401250	26.000	17.1250	121s 5d
31	3.393750	3.403750	25.875	17.0625	121s 3½d
Av. for Month	336.060	.....	25.400	16.883	.....—
			Averages for Week		
4	3.32275	.....	24.475	.....	.....
11	3.34604	.....	25.188	.....	.....
18	3.35146	.....	25.292	.....	.....
25	3.36875	.....	25.667	.....	.....

Calendar week-averages: New York Silver, January 7th, 24.950; 14th, 25.229; 21st, 25.375; 28th, 25.792.

London Market

Jan.	Copper: Standard Spot	Copper: Standard 3 Mo.	Copper: Electrolytic (Bid)	Tin: Spot	Tin: 3 Mo.	Lead: Spot	Lead: 3 Mo.	Zinc: Spot	Zinc: 3 Mo.
2.....				Holiday					
3.....	28.8125	29.1875	34.0000	147.8750	148.7500	10.6875	11.0000	14.9375	15.1250
4.....	28.0625	28.4375	33.2500	141.0000	142.0000	10.3750	10.7500	14.4375	14.7500
5.....	28.1875	28.5625	32.7500	144.2500	145.2500	10.4375	10.7500	14.5625	14.8750
6.....	28.2500	28.6250	33.6250	144.2500	145.0000	10.2500	10.5625	14.5625	14.8125
9.....	28.8125	29.1250	33.5000	145.2500	146.0000	10.3125	10.6875	14.7500	15.0000
10.....	28.8750	29.2500	33.7500	146.3750	146.8750	10.2500	10.6875	14.6250	14.9375
11.....	29.5000	29.8750	34.3750	147.2500	147.8750	10.5000	10.9375	14.8125	15.0625
12.....	29.2500	29.5625	34.2500	147.0000	147.6250	10.6250	11.0625	14.6250	14.9375
13.....	28.6875	29.0000	34.0000	145.6250	146.1250	10.4375	10.8750	14.4375	14.6875
16.....	28.4375	28.7500	33.0000	144.2500	144.7500	10.5000	10.9375	14.3125	14.5625
17.....	28.2500	28.5625	33.0000	145.2500	145.7500	10.5625	10.9375	14.5000	14.7500
18.....	28.2500	28.5625	33.0000	146.0000	146.6250	10.3750	10.8750	14.6250	14.8125
19.....	28.1250	28.4375	33.0000	144.2500	145.0000	10.2500	10.7500	14.4375	14.6250
20.....	28.3125	28.6250	33.0000	145.0000	145.6250	10.2500	10.6875	14.1875	14.3125
23.....	28.8125	29.0625	33.0000	145.5000	146.1250	10.5000	10.8750	14.3125	14.5000
24.....	28.5625	28.8125	32.7500	145.6250	146.1250	10.5000	10.9375	14.3125	14.5000
25.....	28.6875	28.8750	32.7500	146.8750	147.3750	10.6875	11.0625	14.3750	14.5625
26.....	28.5625	28.7500	32.7500	146.7500	147.5000	10.5000	10.7500	14.1250	14.2500
27.....	28.5000	28.7500	32.8750	146.3750	147.0000	10.4375	10.6875	13.5625	13.6875
30.....	28.2500	28.4375	32.7500	146.8750	147.5000	10.5000	10.7500	13.5625	13.6875
31.....	28.5000	28.6875	32.7500	148.2500	148.7500	10.6875	10.9375	13.9375	14.0625
Average for month	28.557	.....	33.244	145.708	.....	10.458	10.833	14.381	14.595

The United States quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are based on a minimum

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1932	1933	1932	1933	1932	1933
January	29.780	25.400	19.623	16.883	342.515	336.060
February	30.136	.....	19.573	.....	345.141	.....
March	29.810	.....	18.336	.....	363.463	.....
April	28.298	.....	16.923	.....	374.731	.....
May	27.755	.....	16.868	.....	367.370	.....
June	27.466	.....	16.844	.....	364.471	.....
July	26.700	.....	16.930	.....	354.865	.....
August	27.986	.....	18.000	.....	347.449	.....
September	27.870	.....	17.998	.....	347.003	.....
October	27.195	.....	17.813	.....	339.500	.....
November	26.698	.....	18.099	.....	327.458	.....
December	25.010	.....	17.110	.....	327.683	.....
Year	27.892	.....	17.843	.....	350.137	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery			London Spot			
	Electrolytic			Standard		Electrolytic	
	Domestic		Export				
	1932	1933	1933	1932	1933	1932	1933
January	7.060	4.775	4.741	39.459	28.557	46.200	33.244
February	5.965	.....	.....	36.917	.....	41.381	.....
March	5.763	.....	.....	33.039	.....	36.786	.....
April	5.565	.....	.....	29.943	.....	34.190	.....
May	5.237	.....	.....	28.548	.....	32.833	.....
June	5.145	.....	.....	26.872	.....	30.841	.....
July	5.053	.....	.....	26.071	.....	29.107	.....
August	5.219	.....	.....	31.401	.....	34.784	.....
September	5.978	.....	.....	34.986	.....	38.318	.....
October	5.733	.....	.....	31.890	.....	36.190	.....
November	5.131	.....	.....	31.972	.....	36.568	.....
December	4.813	.....	.....	29.088	.....	34.344	.....
Year	5.555	.....	.....	31.682	.....	35.962	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1932	1933	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos.
January	3.750	3.000	3.550	2.875	15.084	15.128	10.458	10.833
February	3.712	.....	3.499	.....	14.560	14.571	.....	.....
March	3.150	.....	2.993	.....	12.345	12.634	.....	.....
April	3.000	.....	2.900	.....	11.223	11.503	.....	.....
May	3.000	.....	2.900	.....	10.673	11.036	.....	.....
June	2.993	.....	2.896	.....	9.608	9.898	.....	.....
July	2.747	.....	2.611	.....	9.818	10.152	.....	.....
August	3.235	.....	3.093	.....	11.349	11.588	.....	.....
September	3.465	.....	3.315	.....	13.122	13.349	.....	.....
October	3.052	.....	2.939	.....	11.958	12.170	.....	.....
November	3.050	.....	2.931	.....	12.071	12.395	.....	.....
December	3.000	.....	2.877	.....	11.144	11.541	.....	.....
Year	3.180	.....	3.042	.....	11.913	12.164	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1932	1933	1932	1933
	Straits		Spot	
January	21.804	22.692	140.219	145.708
February	22.018	.....	139.143	.....
March	21.863	.....	129.810	.....
April	19.244	.....	108.935	.....
May	20.948	.....	122.286	.....
June	19.659	.....	114.530	.....
July	20.931	.....	125.863	.....
August	22.985	.....	142.017	.....
September	24.779	.....	152.705	.....
October	23.936	.....	151.280	.....
November	23.354	.....	153.585	.....
December	22.677	.....	149.806	.....
Year	22.017	.....	135.848	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos.
January	3.011	3.018	14.416	14.834	14.381	14.595
February	2.817	.....	13.872	14.289	.....	.....
March	2.787	.....	12.616	13.024	.....	.....
April	2.725	.....	11.670	11.958	.....	.....
May	2.532	.....	12.432	12.682	.....	.....
June	2.777	.....	11.548	11.866	.....	.....
July	2.537	.....	11.592	11.967	.....	.....
August	2.758	.....	13.594	13.844	.....	.....
September	3.322	.....	15.455	15.616	.....	.....
October	3.027	.....	14.869	15.140	.....	.....
November	3.094	.....	15.264	15.534	.....	.....
December	3.124	.....	15.209	15.347	.....	.....
Year	2.876	.....	13.545	13.842	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1932	1933	1932	1933
January	55.000	55.000	23.300	23.300
February	55.000	.....	23.300	.....
March	55.000	.....	23.300	.....
April	55.000	.....	23.300	.....
May	55.000	.....	23.300	.....
June	55.000	.....	23.300	.....
July	55.000	.....	23.300	.....
August	55.000	.....	23.300	.....
September	55.000	.....	23.300	.....
October	55.000	.....	23.300	.....
November	55.000	.....	23.300	.....
December	55.000	.....	23.300	.....
Year	55.000	.....	23.300	.....

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1932	1933	1932	1933	1932	1933
January	5.976	5.722	64.900	48.500	40.000	26.480
February	6.489	.....	66.304	.....	40.000	.....
March	6.188	.....	72.537	.....	40.000	.....
April	5.746	.....	72.125	.....	40.000	.....
May	5.170	.....	66.380	.....	39.500	.....
June	5.034	.....	59.481	.....	37.500	.....
July	5.000	.....	53.580	.....	35.200	.....
August	5.144	.....	47.444	.....	35.000	.....
September	5.606	.....	47.500	.....	33.800	.....
October	5.575	.....	47.600	.....	33.000	.....
November	5.771	.....	48.750	.....	33.000	.....
December	5.400	.....	48.500	.....	30.462	.....
Year	5.592	.....	57.925	.....	36.455	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1932	1933	1932	1933	1932	1933
January	16.00	14.50	15.00	14.00	15.50	14.50
February	15.68	.....	14.68	.....	15.18	.....
March	15.50	.....	14.50	.....	15.00	.....
April	15.50	.....	14.50	.....	15.00	.....
May	15.50	.....	14.50	.....	15.00	.....
June	14.85	.....	14.35	.....	14.75	.....
July	14.56	.....	14.00	.....	14.50	.....
August	14.50	.....	14.00	.....	14.50	.....
September	14.50	.....	14.00	.....	14.50	.....
October	14.50	.....	14.00	.....	14.50	.....
November	14.50	.....	14.00	.....	14.50	.....
December	14.50	.....	14.00	.....	14.50	.....
Year	15.01	.....	14.29	.....	14.79	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces; freight to Pittsburgh, $1.89.

price basis of 4½c. per pound.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

New York silver quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent forenoon market demand. Cables command a premium.

Current Statistics of Production and Stocks of Copper, Lead, and Zinc

Data from American Bureau of Metal Statistics, American Zinc Institute, and Metallgesellschaft.

All Figures Except Tin Represent Tons of 2,000 Lb.

	1932											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
COPPER—North and South America												
Production, refined, daily average	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Domestic shipments	.....	.....	.....	.....	.....	.....	.....	(*a*) 18,300	(*a*) 19,700	(*a*) 25,500	(*a*) 25,000	.....
Foreign shipments	.....	.....	.....	.....	.....	.....	.....	(*a*) 48,000	(*a*) 53,700	(*a*) 55,500	(*a*) 55,000	.....
Stocks, blister and refined	.....	.....	.....	.....	.....	.....	.....	.....	(*b*) 775,000	(*b*) 773,000	(*b*) 770,000	.....
LEAD — United States												
Production, refined, from domestic ore	32,180	28,081	30,345	23,236	25,902	26,068	15,819	17,118	20,498	21,092	24,465	21,638
Production, secondary and foreign	3,554	3,920	3,989	3,134	2,941	2,033	3,754	6,308	2,315	6,984	2,873	3,165
Production, total, daily rate	1,185	1,103	1,107	879	930	936	631	756	760	905	901	800
Shipments reported	27,867	26,319	31,162	26,081	24,258	21,511	19,723	28,248	26,413	29,764	22,838	23,765
Stocks, end of month	160,257	165,933	169,091	169,091	173,929	180,460	180,255	175,426	171,831	170,171	174,629	175,661
ZINC — United States												
Production, daily average	723	742	726	688	601	547	476	432	434	480	525	596
Domestic shipments	22,472	21,896	22,576	18,046	18,087	14,958	12,896	18,069	21,132	18,801	16,000	15,582
Export shipments	31	.....	.....	.....	.....	24	.....	39	20	20	20	.....
Stocks, end of month	129,886	129,506	129,451	132,025	132,580	134,032	135,907	131,203	123,056	119,101	121,798	124,705
World Production Rate (Daily Average)												
Copper	.....	.....	.....	.....	.....	.....	.....	.....	(*b*) 2,500	(*b*) 2,477	(*b*) 2,480	.....
Lead	3,938	3,872	3,598	3,587	3,711	3,497	3,190	3,334	3,323	3,510	3,518	.....
Zinc	2,600	2,615	2,623	2,528	2,392	2,343	2,224	2,121	2,120	2,255	2,343	2,381
Tin (Metric Tons)	311	274	340	312	311	261	178	179	255	249	247	222

(*a*) Deliveries from all sources; private estimate. (*b*) *E.&M.J.* estimate.

Editor: A. W. ALLEN

Associate Editors: A. H. HUBBELL, H. D. KEISER

Assistant Editor: W. N. P. REED

Market Editor: H. H. WANDERS

Publishing Director: H. W. CLARKE

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